APPENDIX K

TECHNICAL MEMORANDUM #7

City-Wide Sanitary Servicing Master Plan Update: Technical Memorandum 7 - FINAL

Definition and Evaluation of Servicing Alternatives

Prepared for:
City of Waterloo

Prepared by:
Stantec Consulting Ltd.

1611 11191

August 20, 2015

Sign-off Sheet

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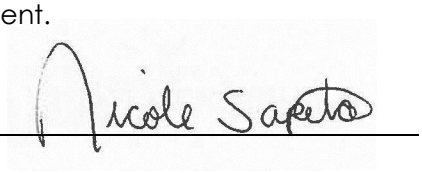
Prepared by 
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1.0 INTRODUCTION

The City of Waterloo (City) has retained Stantec Consulting Ltd. (Stantec) to complete the Waterloo Sanitary Servicing Master Plan Update (Master Plan). The purpose of the Master Plan is to account for increases in population and employment growth projections up to a planning horizon of 2031. Priority and strategic projects will be evaluated to allow the system to continue to efficiently and effectively operate, implement best management practices, and optimize staging of the sanitary capital program.

The following tasks form the basis of the Master Plan:

- Task 1: GIS Sanitary Quality Control and Field Verification - Complete
- Task 2: Hydraulic Needs Assessment - Complete
- Task 3: Hydraulic Model Benefit/Cost Analysis - Complete
- Task 4: Hydraulic Model Development, Train, and Implement
- Task 5: Flow Monitoring and Inflow/Infiltration
- Task 6: Public Consultation
- Task 7: Master Plan

As part of Task 7, existing and future conditions are to be assessed to identify recommended upgrades. The purpose of this Tech Memo is to outline the capacity analysis and needs assessment, identification of alternatives and recommendations, and selection of preferred alternatives. Preliminary staging and implementation recommendations are also provided.

2.0 BACKGROUND

2.1 DESIGN CRITERIA

A hydraulic model for the sanitary collection system was developed and calibrated based on existing conditions and was used as a baseline for evaluating future conditions. Details regarding the model development are provided in Tech Memo 6. Planning data was used in conjunction with a design per capita rate to estimate the average dry weather flow for proposed growth. Diurnal patterns determined as part of the model calibration were applied to new development areas to determine the peak dry weather flows. The diurnal pattern was assigned to the development area based on the sewers receiving flow from the proposed development.

An allowance of 0.15 L/s/ha was assigned for baseline flow (groundwater infiltration) from Greenfield developments. In developments related to infill and intensification, a baseline flow was already determined for the existing sewers based on the model calibration. The inflow and infiltration for the response to wet weather events was assigned for future development based on the RTK values developed during model calibration and the 10-year, 3 hour Chicago design storm[1]. In the near-term, the impact of wet weather from new development should not be as excessive as the calibrated older areas, since private-side extraneous flow connections are illegal and not connected to the sanitary system, and new construction should exhibit good seals and structural integrity if proper inspection and installation practices are observed. Therefore, the application of the calibrated RTK parameters to new areas is considered conservative.

A summary of the design criteria used for developing the future scenarios in the hydraulic model is provided in Table 2-1.

[1] The RTK unit hydrograph method is a widely accepted approach to wet weather flow (WWF). The RTK method generates the total inflow and infiltration (I/I) into the sanitary sewer system by combining triangular unit hydrographs from three components of flow: rapid inflow, moderate infiltration, and slow infiltration. Details can be found in Tech Memo 6.

Table 2-1: Summary of Design Criteria for Future Development Flows

Parameter	Design Criteria
Per Capita Rate	350 L/cap/day.
Peak Factor	Diurnal patterns applied from model calibration based on the sewershed receiving flows from the proposed development.
Groundwater Infiltration	Greenfield Development: Allowance of 0.15 L/s/ha. Infill and Intensification: Sewershed specific based on model calibration and the sewers receiving flow from proposed development.
Wet Weather Infiltration	Sewershed specific RTK parameters based on model calibration and the sewers receiving flow from proposed development.
Wet Weather Storm Event	10-year, 3 hour, Chicago Design Storm.

2.2 TARGET LEVEL OF SERVICE

The target level of service is based on the capacity in the collection system and the risk of surcharging that would result in basement flooding. For dry weather flow (DWF) analysis, the ratio of maximum depth versus full depth (d/D) shall be used to identify capacity constraints. The d/D ratio is more appropriate than the maximum flow versus full flow (q/Q) as it is more representative of system capacity for a dynamic model. In dynamic models, the slope of the hydraulic grade line can be greater than the pipe slope, thereby giving a false capacity error if only looking at flow ratio. Based on industry best practices, any sewers with a d/D equal to or greater than 0.8 (80%) shall be identified as having capacity constraints.

For wet weather flow (WWF) events, surcharging (d/D of greater than 1) is considered acceptable provided the water level remains at least 1.8 m below ground elevation. A water level of 1.8 m below ground elevation coincides with the assumed basement elevation for homes with direct or indirect basement connections to the sewer. An increase in water level beyond this would present a risk for basement flooding. Locations without house connections may further experience surcharge without risk of flooding, however these shall be identified on a case-by-case and be considered an exception. Figure 2-1 illustrates the targeted level-of-service for WWF events in relation to the water elevation and typical basement elevations.

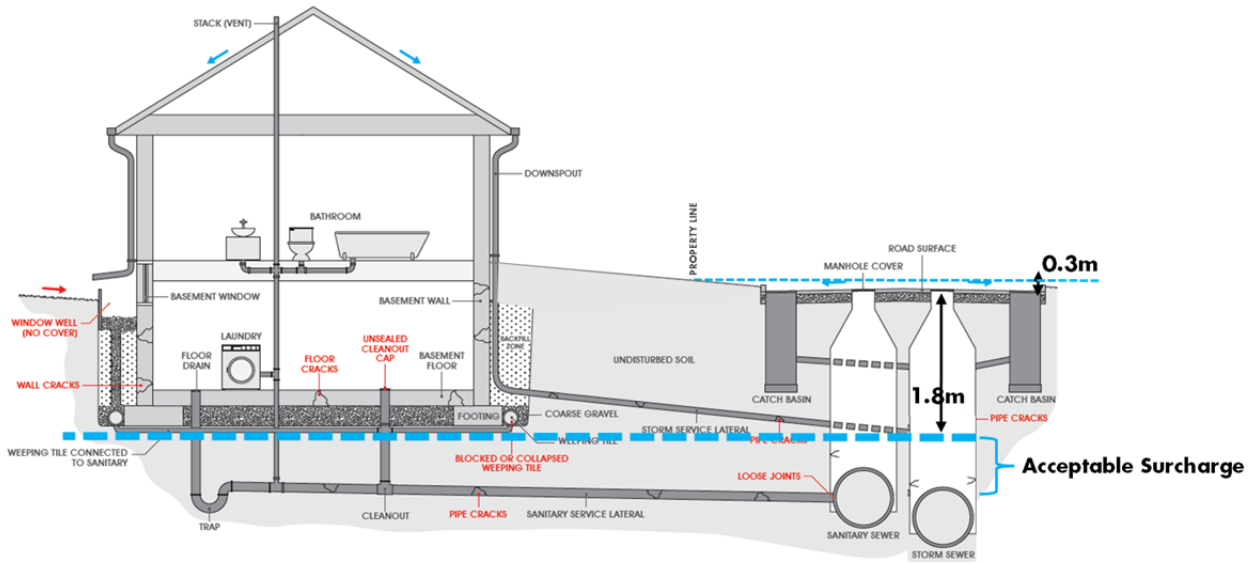


Figure 2-1: Definition of Flooding in Separated Sewer Systems

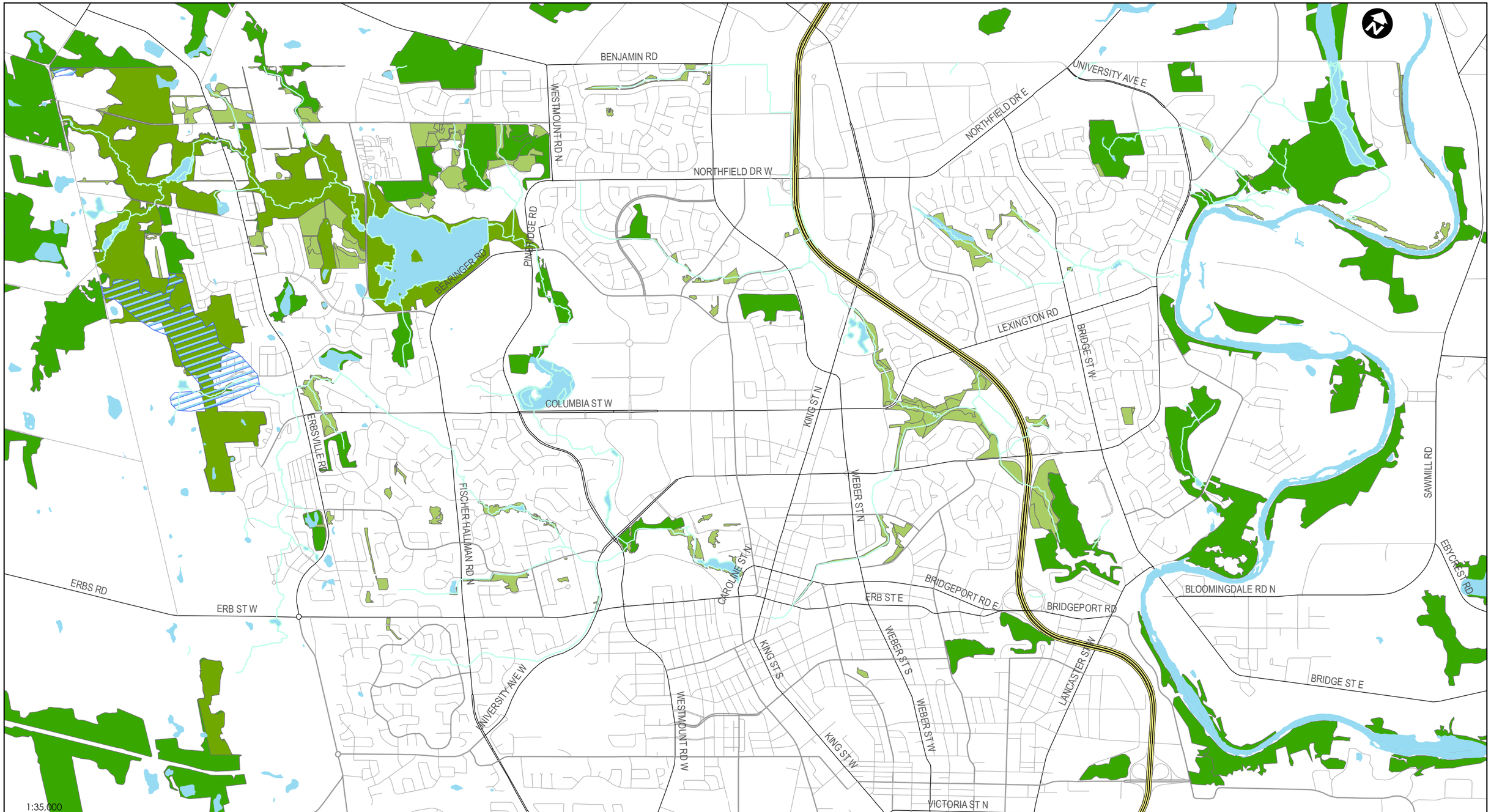
2.3 NATURAL, SOCIAL, AND ECONOMIC INVENTORIES

As part of the evaluation of alternatives, the natural, social, and economic impacts will be taken into consideration to evaluate alternatives and identify preferred solutions. To support this evaluation process, a desktop inventory was completed for natural, social, and economic features.

Natural features identified for consideration in the evaluation process included: water bodies, wetlands, floodplains, woodlands, wellhead protection areas, and well recharge areas. Figure 2-2 provides a map of the natural features identified within the City.

Social, heritage, and archaeological features identified for consideration include designated heritage buildings, areas of archaeological potential, parks, shopping centers, universities and colleges, and community centers (including recreational complexes and libraries). Figure 2-3 provides a map of the social and heritage features identified within the City. Areas of archaeological potential within the City have been identified by the Region of Waterloo and are shown in Figure 2-4.

Economic features for consideration in the evaluation process included: urban growth areas, LRT Station Locations, LRT Station Areas, and areas of existing commercial, institutional, or industrial land uses. Urban growth areas were identified based on areas of expected infill and intensification within the Uptown Waterloo area. LRT Station Locations and Station Areas are related with LRT Station Locations representing the rapid transit stations for the LRT and LRT Station Areas representing the surrounding land that is considered to be within a 10 minute walk from the station (approximately 800 m). Areas of commercial, institutional, and industrial land uses were identified based on existing land use zoning. Figure 2-5 provides a map of the economic features identified within the City.



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Legend

Ontario_Road_Network

Transportation Network

- Arterial
- Collector
- Highway
- Local

- Creeks
- Water Body
- Environmental Lands
- RegionalRechargeArea_ROP10
- Natural Features
- Region Forests

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Figure No. FIGURE 2-2

Title **Natural Features**

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2.4 POPULATION FORECASTS

Population forecast data was provided during model development for the 2014, 2019 and 2024 planning horizons based on the *Development Charges Background Study* (Hemson Consulting Ltd., 2012). Subsequently, population forecasts for the 2029 planning horizon were provided based on the *City-Wide Growth Forecast* (nblc, BrookMcIlroy, and CH2MHill, 2014). Table 2-2 provides an overview of the forecasted population for each planning period.

Table 2-2: Overview of Forecasted Population by Planning Period

Planning Period	Population	
	Residential	Employment
Existing Conditions	120,453	63,473
2014	126,044	63,661
2019	135,932	72,721
2024	146,573	79,429
2029	152,613	90,368

BENJAMIN RD
WESTMOUNT RD N
NORTHFIELD DR W
NORTHFIELD DR E
UNIVERSITY AVE E
PINERIDGE RD
BEARINGER RD
LEXINGTON RD
BRIDGE ST W
COLUMBIA ST W
KING ST N
WEBER ST N
SAWMILL RD
EBY CREST RD
ERBSVILLE RD
FISCHER HALLMAN RD N
ERBS RD
ERB ST W
ERB ST E
CAROLINE ST
KING ST
UNIVERSITY AVE W
WESTMOUNT RD W
BRIDGEPORT RD E
BRIDGEPORT RD
WEBER ST S
WEBER ST W
LANCASTER ST W
BLOOMINGDALE RD N
BRIDGE ST E
KING ST W
VICTORIA ST N

1:35,000

Legend

- CityBoundary
- Cycle Routes
- Heritage District
- Heritage Properties
- Parks
- Community Centre
- University / College
- Conestoga Mall
- Waterloo Town Square

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Figure No. FIGURE 2-3

Title **SOCIAL FEATURES**

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530000 532000 534000 536000 538000 540000 542000

4820000 4818000 4816000 4814000 4812000 4810000

N

NORTHFIELD DR E
UNIVERSITY AVE E
NORTHFIELD DR W
DAVENPORT RD
BRIDGE ST W
LEXINGTON RD
WOOLWICH ST
CONESTOGA PKY
PARKSIDE DR
WEBER ST N
KING ST N
CONSERVATION DR
BEARINGER RD
PHILLIP ST
ALBERT ST
LINCOLN RD
BRIDGEPORT RD E
ERB ST E
WEBER ST S
KING ST S
LAUREL WOOD DR
COLUMBIA ST W
WESTMOUNT RD N
FISCHER-HALLMAN RD N
ERBSVILLE RD
KEATS WAY
ERB ST W
WESTMOUNT RD S
FISCHER-HALLMAN RD S
IRA NEEDLES BLVD
UNIVERSITY AVE W

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Revised: 2015-04-09 By: jehale

Stantec

Legend

- CityBoundary
- PropertyFabric

Assessment Potential

- Assessment Always Required
- Assessment Required
- Assessment Required - Except Consents
- Assessment Possibly Required
- Assessment Not Required

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the City of Waterloo.
3. Assessment Potential information derived from Region of Waterloo mapping (2015).

April 2015
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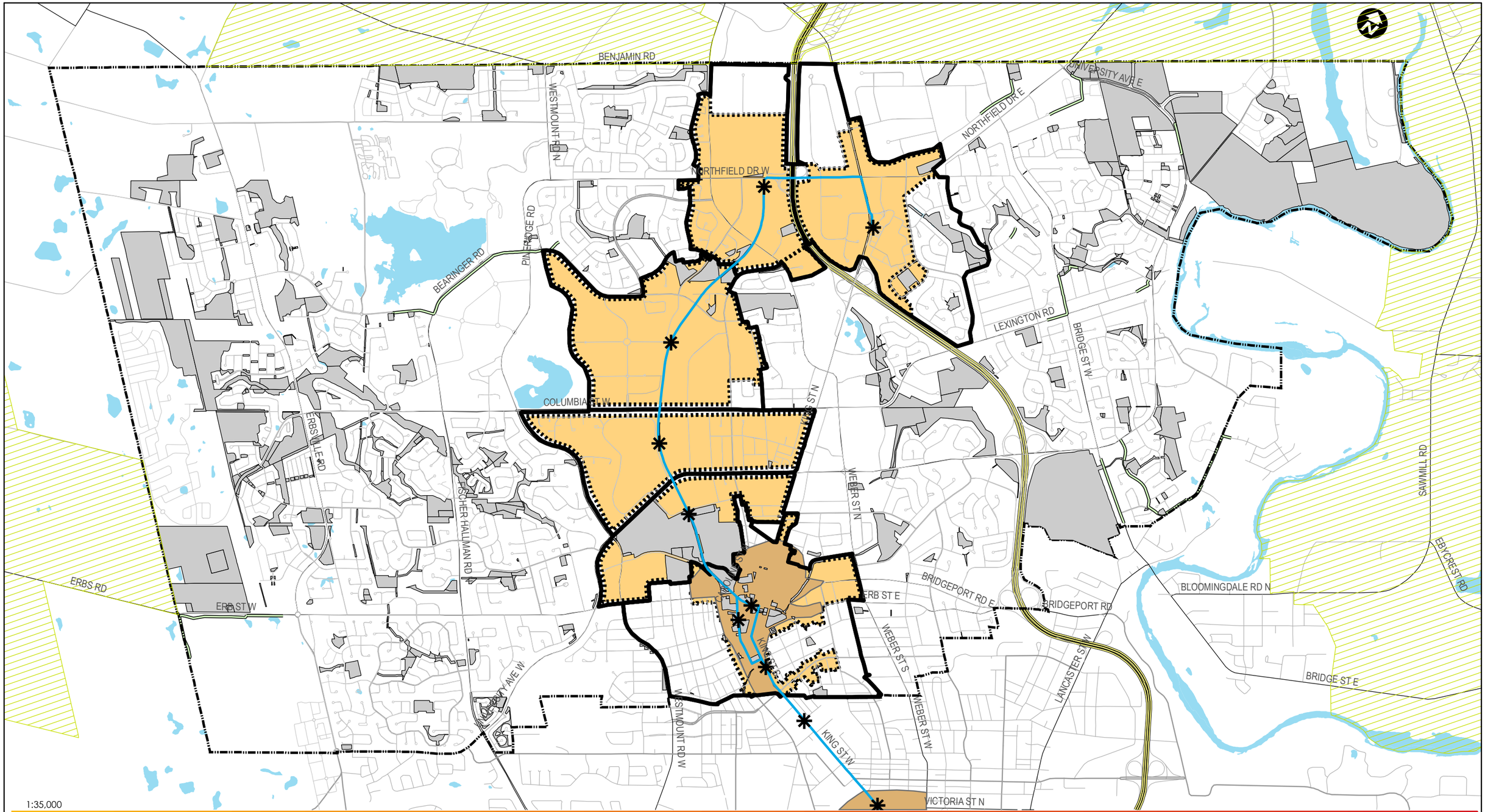
Figure No.

2-4

Title

Archaeological Assessment Potential



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Legend

Ontario_Road_Network
Transportation Network
- Arterial
- Collector
- Highway
- Local

- Water Body
- CityBoundary
- Prime Agriculture
- Urban Growth Cities
- City Owned Lands
- LRT Study Area
- Conceptual Station Area

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Figure No. FIGURE 2-5

Title **Economic Contributions**

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3.0 2029 SCENARIO MODEL DEVELOPMENT

Planning data for the 2029 planning period became available after the initial model development for future scenarios 2014, 2019, and 2024. As a result, the development of the 2029 model scenario was not fully documented in Tech Memo 6, and additional details have been provided in the following sections.

3.1 DRY WEATHER FLOW

3.1.1 Population Data

As indicated above, the population forecasts for the 2029 planning horizon were provided based on the *City-Wide Growth Forecast* (nblc, BrookMcIlroy, and CH2MHill, 2014). The spatial allocation of population growth in 2029 was focused on four distinct areas: 1) Designated Greenfield, 2) Nodes & Corridors, 3) Remaining City Lands, and 4) Station Areas. The growth in the Designated Greenfields, Nodes and Corridors, and Remaining City Lands was allocated based on the *Staging of Development Report 2011-2014* (City of Waterloo, 2011) and the *City Official Plan* (City of Waterloo, 2014). Growth within the Station Areas was allocated based on a development capacity assessment provided by the City.

3.1.1.1 Residential Population Growth

The residential population growth was allocated based on the *Staging of Development Report 2011-2014* (City of Waterloo, 2011) for areas categorized as Designated Greenfields, Nodes and Corridors, and Remaining City Lands. Full-build-out conditions were assumed for all parcels identified in the *Staging and Development Report* (City of Waterloo, 2011), and additional population growth beyond the full-build out conditions that were accounted for in the Report was allocated to existing parcels to represent infill and redevelopment. Existing loadings were uniformly increased within each planning category to account for the increase in population that was associated with infill and redevelopment. The increases to existing loadings were applied as follows:

- Designated Greenfields – 131.8%
- Nodes and Corridors – 25.4%
- Remaining City Lands – 0.2%

The allocation of residential population growth within the Station Areas was based on the development capacity assessment provided by the City. The development capacity for a given location was used to weight the portion of the total residential growth allocated for the 2029 planning horizon. It can be noted that the 'Low Density' development capacity assessment scenario was used to determine the weightings for allocating growth.

3.1.1.2 Student Population Growth

The growth in student population was allocated for the 2029 planning period using the same methodology used for the 2019 and 2024 periods. Details regarding this methodology are provided in *Technical Memorandum 6* (Stantec, February 2015). In general, growth for Off-Campus students was assumed to be concentrated in areas already indicating high student populations. Five Dissemination Areas (DAs) were identified for allocating growth for Off-Campus student populations (populations greater than 990 students), and the population increase within each DA was allocated to individual parcels based on water consumption record (i.e. parcels with a higher existing water usage were assigned larger populations). On-campus students were assumed to remain unchanged from existing conditions for the 2029 planning period.

3.1.1.3 Employment Population Growth

The employment population growth was allocated based on the *Staging of Development Report 2011-2014* (City of Waterloo, 2011) and the *City Official Plan* (City of Waterloo, 2014) for areas categorized as Designated Greenfields, Nodes and Corridors, and Remaining City Lands. Similar to allocating residential population growth, full build-out conditions were assumed for parcels identified in the *Staging of Development Report 2011-2014* (City of Waterloo, 2011). The *City-Wide Growth Forecast* (nblc, BrookMcIlroy, and CH2MHill, 2014) indicated a substantial increase in employment population growth beyond that projected for full-build out in the *Staging of Development Report 2011-2014* (City of Waterloo, 2011) when assuming a target density of 40 jobs/hectare (based on Region-wide targets indicated in the *City Official Plan* (City of Waterloo, 2014)). To allocate the difference in forecasted population, the *City Official Plan* (City of Waterloo, 2014) was reviewed to identify current and future employment lands beyond those identified in the *Staging of Development Report 2011-2014* (City of Waterloo, 2014). A population density increase was determined for these employment lands based on each planning category (i.e. Designated Greenfield, Nodes and Corridors, or Remaining City Lands) to allocate the difference in growth.

In the case of Designated Greenfields, the population density for the remaining employment lands after assuming full build-out for lands identified in the *Staging of Development Report 2011-2014* (City of Waterloo, 2011) was not considered realistic (i.e. the population density for the remaining lands was too high). To provide a more reasonable allocation of employment population growth, one population density for allocating new growth was assumed for all employment lands within the Designated Greenfields, regardless of whether the lands were identified in the *Staging of Development Report 2011-2014* (City of Waterloo, 2011).

Similar to the methodology for the residential population growth, employment population growth was allocated within the Station Areas based on the development capacity assessment provided by the City. The development capacity for a given location was used to weight the portion of the total employment growth allocated for the 2029 planning horizon. It can be noted that the 'Low Density' development capacity assessment scenario was used to determine these weightings.

3.2 ASSIGNED FLOW RATES

3.2.1 Sewage Per Capita Rate

The design criteria used for developing the 2014, 2019, and 2024 model scenario were also used for the 2029 scenario. A per capita rate of 350 L/c/d was used for both residential and employment growth (refer to Tech Memo 6 for additional details).

3.2.2 Baseline Flow (Groundwater Infiltration)

An infiltration allowance of 0.15 L/s/ha was considered for future growth areas, as specified in the *Design Guidelines and Supplemental Specifications for Municipal Servicing (DGSSMS)* (Region of Waterloo, 2014). It can be noted that the Core Area infill was not attributed any increases in area; therefore, the design rate was not applied.

3.3 EXTERNAL FLOWS

3.3.1 Waterloo Waste Management Site Leachate Flow

As discussed in Tech Memo 6, the Waterloo Waste Management Site collects leachate and a pump station (referred to as PS-3) discharges into the City's sanitary network along Ira Needles Boulevard (Manhole reference CH25-18, Model ID 15530). The agreement between the Region and the City regarding the leachate discharge is currently being updated. Based on the information available at this time, the expected discharge for the 2029 period is expected to be a maximum of 15.2 L/s. The projected volume of leachate expected for 2029 (based on the *Leachate Management Plan Update* (Conestoga-Rovers & Associates (CRA), 2013) is approximately 287 m^3/d (refer to Tech Memo 6 for additional details)

3.3.2 Stockyards Development

Information regarding the Stockyards Area was provided by the Township and determined based on flow monitoring data, as discussed in Tech Memo 6. Details regarding the staging of development in this area were not available at this time, therefore, it was assumed all growth occurred by the 2019 planning period to provide a conservative estimate of flows. As a result, the loading for the 2029 model scenario with respect to the Stockyards Area is unchanged from the 2019 and 2024 model scenarios. The design flows for these scenarios are as follows:

- Average Flow – 6.7 L/s:
  - 4.4 L/s applied to MH ID 15639 (F38-4B)
  - 2.3 L/s applied to MH ID 11908 (F47-1)
- Peak flow – 13.7 L/s:
  - 9.1 L/s applied to MH ID 15639 (F38-4B)

- 4.6 L/s applied to MH ID 11908 (F47-1)

- Baseline Flow – 4.6 L/s:
  - 1.8 L/s applied to MH ID 15639 (F38-4B)
  - 2.8 L/s applied to MH ID 11908 (F47-1)

3.3.3 Inflows from the Village of St. Jacobs

In the future, flows from the Village of St. Jacobs are to be diverted to the City's sanitary network for treatment at the Waterloo Wastewater Treatment Plant (WWTP). The timing for diverting flows is uncertain, however, it was assumed to take place within the next 10 years. The projected flow to be generated by St. Jacobs in 2029 is 1,393 m^3/d (16.12 L/s) based on the *2013 Water and Wastewater Monitoring Report* (Region of Waterloo, 2013). This flow was applied to model node 11904 (Manhole FWL-43). The strategy for managing the discharge into the City's collection system from St. Jacobs is still to be confirmed; for the purposes of this study, the flow was assumed to be constant (refer to Tech Memo 6 for additional details).

3.3.4 Large User Flows

Two large users have been identified as having the potential to significantly impact localized flows. Specifically, the purge well (Well W14) located in Uptown Waterloo and Kraus Flooring were identified as large users of concern. The same flow rates were used for all future planning periods, therefore, the loading for the 2029 scenario remains unchanged from the 2024 scenario. Loading for these users was applied as follows:

- Purge Well W14 – 9.54 L/s:
  - Applied at MH ID 12652
- Kraus Flooring – 6.94 L/s:
  - Applied at MH ID 12036

3.3.4.1 Bridgeport Pumping Station (Region of Waterloo)

As noted in Tech Memo 6, the catchment area for Bridgeport PS is split across the Kitchener-Waterloo Boundary. The growth in the catchments upstream of the Bridgeport PS is uncertain, therefore, the firm capacity of the pump station was applied for all future scenarios to provide a conservative approach. The firm capacity of the pump station is 273 L/s, as per the Certificate of Approval (CofA).

3.3.4.2 Falconridge Pumping Station (City of Kitchener)

Peak flows were reported for the Falconridge PS within the *City-wide Sanitary Sewer System Capacity Study* completed by AECOM in 2011 for the City of Kitchener. The peak flow rates for 2024 and 2029 were assumed to be the same (representing 100% growth); therefore, the Falconridge PS flow remains unchanged between the 2024 and 2029 model scenarios. The peak flow estimated for the pump station was approximately 26 L/s (applied at MH ID 15579 (LEX-15A)).

3.3.4.3 Waterloo North Water Treatment Plant

The proposed Waterloo North Water Treatment Plant (WTP) is to be constructed near the intersection of Westmount Road North and Conservation Drive. Based on the Water Supply Master Plan (Stantec, ongoing), the estimated production rate for the new WTP is approximately 80 L/s. Sewage generation from the WTP is estimated to be 20% of plant capacity, which would result in approximately 16 L/s that will be discharged to the City's collection system. This loading has been applied at Manhole ID 7551 for the 2029 model scenario. It can be noted that the timing of the WTP is to be finalized. To provide a conservative estimate of flows, modifications were made to the 2024 model scenario to include the loading from this facility as well.

4.0 2029 SCENARIO MODEL RESULTS

4.1 DRY WEATHER MODELING RESULTS

The dry weather flow scenario has been assessed for the 2029 planning period. The results are displayed in Figure 4-1 for the d/D ratio in the links and the minimum freeboard in the nodes.

The constraint downstream of Frobisher PS is identified within the 2029 scenario. This constraint was also identified in the current state model, and the other planning periods (2014, 2019, and 2024) and follow up is recommended to confirm the pump curves for the Frobisher PS, as discussed in Tech Memo 6. Aside from this location, no other sewers indicate capacity constraints under DWF conditions up to the 2024 planning horizon.

4.2 WET WEATHER MODELING RESULTS

The 10-yr, 3 hour Chicago storm event was reviewed for the 2029 planning periods to evaluate the impact on the system. The results are displayed in Figure 4-2 for the d/D ratio in the links and the minimum freeboard in the manholes.

The model indicates areas of surcharging as a result of sewers being at capacity:

- Downstream of Frobisher PS
- A section of Maple Hill Trunk
- Downstream of Beaver Creek PS

Downstream of Frobisher PS and the section of the Maple Hill Trunk were previously identified as areas experiencing surcharging for the calibrated current state conditions, and the WWF model simulations for the other planning periods (2014, 2019, 2024).

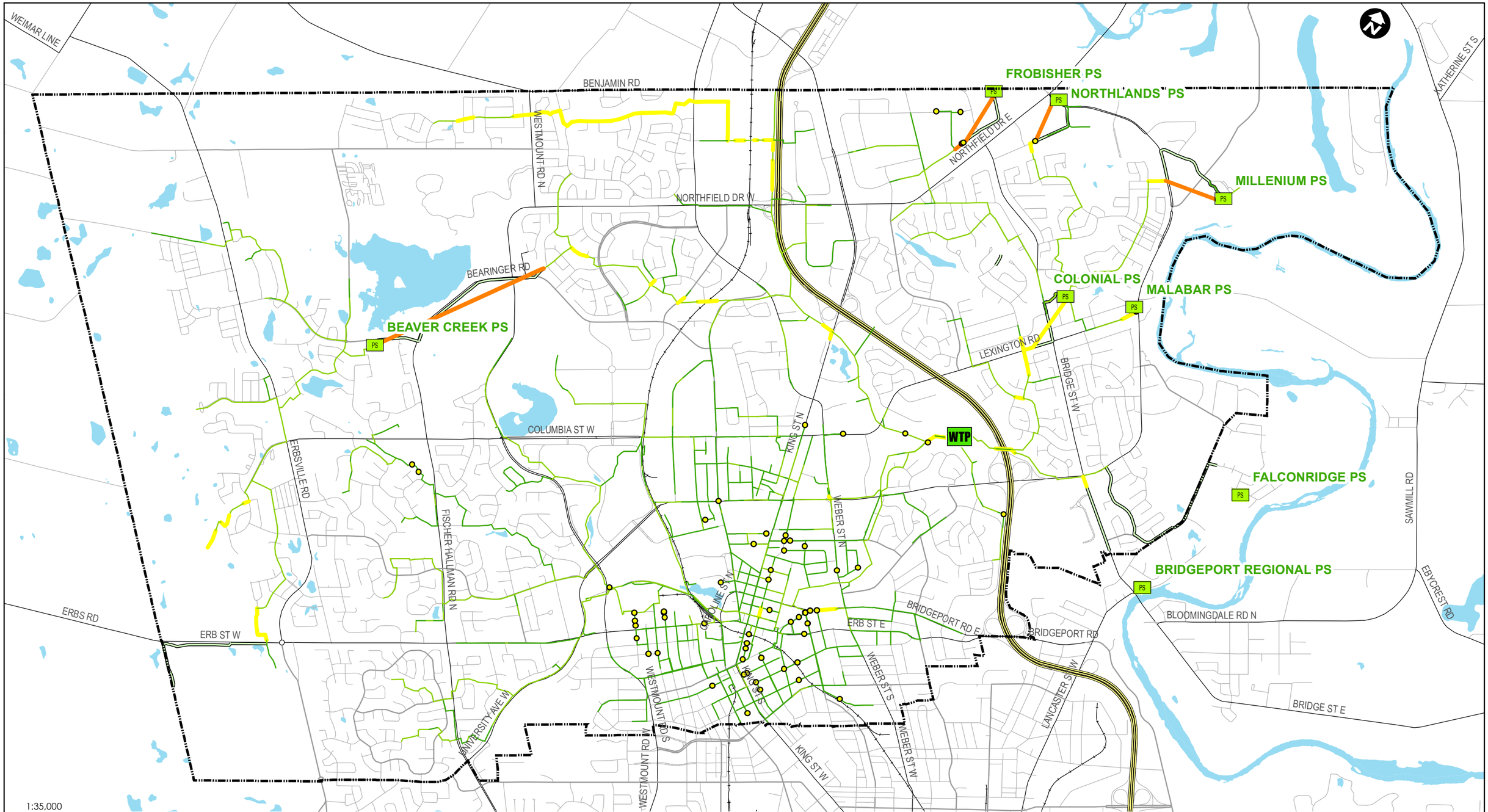
Monitoring was recommended for the Frobisher PS to confirm results, as discussed in Tech Memo 6. In the case of the Maple Hill Trunk, surcharging occurs along an easement and follow-up is recommended to confirm the potential risk to basement flooding, as there may not be any connections along this section.

Capacity constraints are identified in the receiving pipes downstream of the Beavercreek PS. Due to the growth in the upstream catchment areas, the flows exceed the capacity of the receiving sewers, and therefore upgrades will be required to accommodate these flows.

The Lower Forwell Trunk shows surcharging at node 9188 (Manhole FWL-4A), however, further review of the model results determined that the peak water level reported was the result of a computational instability that is not reflective of anticipated levels in the system. Based on flows,

a more representative maximum depth at this location is 1.9 m, which is outside of the 1.8 m depth used to define a capacity constraint. Model instabilities are common in dynamic models of this size and complexity. Measures to eliminate the instability through routing time-step reduction have already been implemented. Physical network changes within the model may alleviate the computational instabilities, but these were not applied given the isolated nature of the spike, and the preference to maintain the modelled network as close as possible to the underlying GIS asset data.

The Beaver Creek PS was reviewed to assess potential concerns associated with the proposed capacity upgrades. In the *Beaver Creek Capacity Assessment Report* (Gamsby and Mannerow, 2012), a peak instantaneous flow rate of 439 L/s was recommended for ultimate build-out conditions for a planning horizon of 2022. In the 2029 Model Scenario, with the 10-yr Chicago design storm applied, the pump station operates at a peak capacity of 610 L/s. This exceeds the recommended capacity of 440 L/s recommended by the *Beaver Creek Capacity Assessment Report*.



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Legend

Transportation Network
- Arterial
- Collector
- Highway
- Local
- CityBoundary

- Water Body
- PS Existing Pump Station
- Forcemain
- WTP Wastewater Treatment Plant

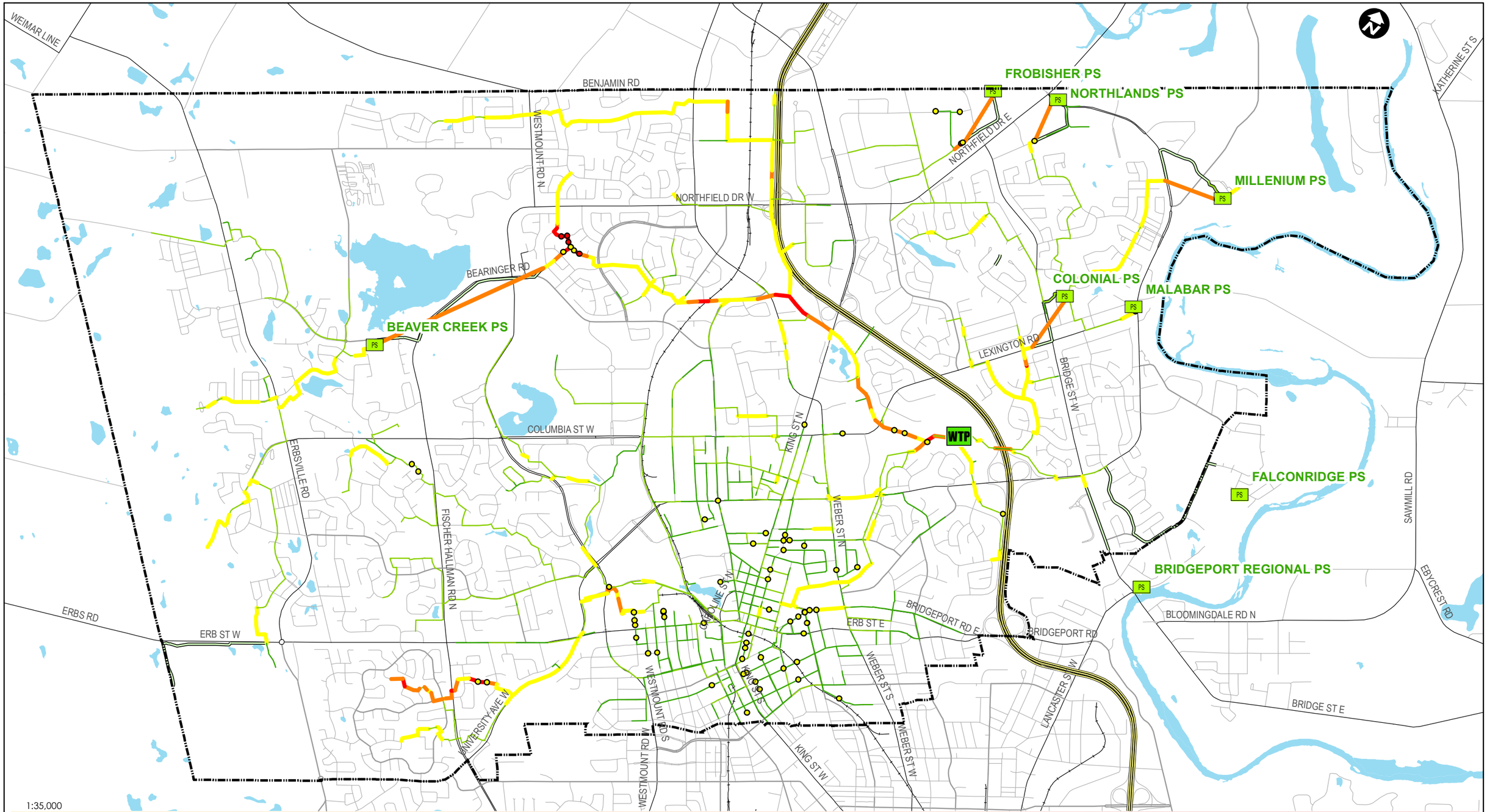
HGL Freeboard
- Above Ground
- Basement Depth (<1.8m)

d/D Ratio
- 0% - 20%
- 21% - 50%
- 51% - 80%
- 81% - 99%
- 100%

Figure No. FIGURE 4-1

Title **DWF MODELING RESULTS FOR FUTURE 2029 CONDITIONS**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE



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- PS Existing Pump Station
- Forcemain
- WTP Wastewater Treatment Plant

HGL Freeboard
- Above Ground
- Basement Depth (<1.8m)

d/D Ratio
- 0% - 20%
- 21% - 50%
- 51% - 80%
- 81% - 99%
- 100%

Figure No. FIGURE 4-2

Title **WWF MODELING RESULTS FOR FUTURE 2029 CONDITIONS (10 YR, 3 HR, CHICAGO STORM)**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE

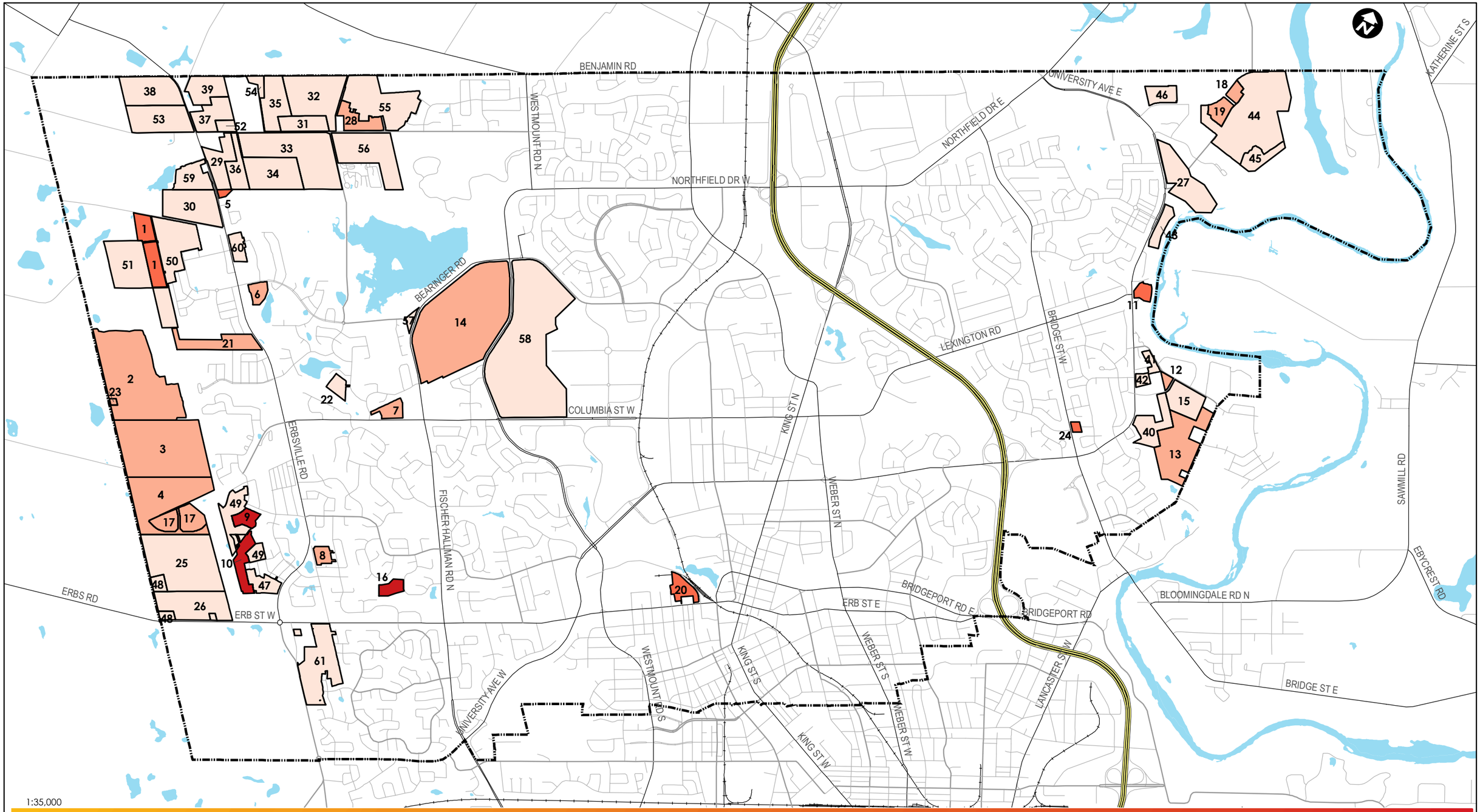
5.0 CAPACITY ANALYSIS AND NEEDS ASSESSMENT

5.1 PROPOSED DEVELOPMENT AND FUTURE SERVICING

5.1.1 Greenfield Development

Greenfield development areas were identified for the purposes of the Master Plan based on the following two sources: the *Staging of Development Report 2011-2014* (City of Waterloo, 2011) and additional Designated Greenfield areas identified in the *City-Wide Growth Forecast* (nblc, BrookMcIlroy, and CH2MHill, 2014) that were beyond the planning period of the Staging of Development Report. A map of the Greenfield areas is provided in Figure 5-1 and parcel information and servicing strategies are provided in Table 5-1 for the parcels identified in the Staging and Development Report and for the additional Designated Greenfield areas identified in the *City-Wide Growth Forecast*.

The staging of development provided in the *Staging of Development Report 2011-2014* (City of Waterloo, 2011) was used in conjunction with site visits to assign planning periods to each parcel. The assigned planning periods are colour coded in Figure 5-1, and indicate that the majority of development is forecasted to occur by 2024. The additional Designated Greenfield areas identified in the *City-Wide Growth Forecast* are expected to be developed by 2029, and have been included in the 2029 Model scenario only.



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Development Area with ID Number

Completion Timeframe (estimated)

- 2014
- 2019
- 2024
- 2029

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Figure No. FIGURE 5-1

Title **PROPOSED DEVELOPMENT AND ADDITIONAL GREENFIELD AREAS**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE

Table 5-1: Servicing Strategies for Greenfield Growth Areas

Parcel ID	Location		Description of Development Parcel Sanitary Servicing	Year Expected to be Completed
	Street Address	Development Name		
1	Wideman Road	Owen	Sanitary services to be extended from the existing residential subdivision to the east.	2019
2	450 Wilmot Line & 500 Wilmot Line	Vista Hills	Sanitary services to be via the Cedar Trunk 2 extension, which was installed between 2007 and 2013.	2024
3	340 Wilmot Line	Clair Creek Meadows	Sanitary services to be extended from 30T-97024 (Parcel ID 2) to the north.	2024
4	250 Wilmot Line	Greyerbiehl	Southern portion of the property to receive sanitary services from the Clair Hills subdivision to the east (extension of sewer at intersection of Columbia St. and St. Moritz). Northern portion of the property to receive sanitary services from 30T-05403 (Parcel ID 3) to the north.	2024
5	672 Trillium Estates Ltd	Trillium Area 7	Sanitary services to be extended northward on Erbsville Road.	2019
6	Laurelwood Drive	Trillium - Laurelwood	Servicing via an existing 200 mm sanitary sewer on Laurelwood Drive.	2024
7	460 Columbia	Trillium - Columbia	No sanitary sewer on Columbia Street, however, road reconstruction is planned for Columbia St in 2014/2015.	2029
8	76, 86, 90 Erbsville Court & 70 Erbsville Court	Lederer Et. Al/ Vanden Berg	Sanitary servicing to be extended from existing 200 mm sanitary sewers on Paradise Crescent and Beechwood Drive.	2024
9	Bamberg Crescent	Clair Hills	Sanitary servicing to development available.	2014
10	Montpellier Street	Montpellier	Sanitary servicing to development available.	2014
11	745 University Avenue East	Kauffman Estates	Sanitary servicing to development available.	2019
12	Wismer Street and Woolwich Street	Triple Crown Estates	Sanitary services to be extended westward on Woolwich Street from Falconridge Drive. Temporary pumping station permissions granted.	2029
13	Woolwich Street	Woolwich Estates	Sanitary services to be extended to convey flow to the Melitzer Creek PS in Kitchener.	2024

Parcel ID	Location		Description of Development Parcel Sanitary Servicing	Year Expected to be Completed
	Street Address	Development Name		
14	Fischer-Hallman Road	UW North Campus	Subject to a memorandum of understanding between the City of Waterloo and the University of Waterloo for grading, road works and installation of services (storm, sanitary, water, utilities).	2024
15	Woolwich Street	Galantai	Sanitary services to be extended westward on Woolwich Street from Falconridge Drive.	2029
16	435 Winchester Drive	Winchester	Serviced via a 200 mm sanitary sewer on Winchester Drive.	2014
17	250 The Wilmot Line	Greyerbiehl (South)	Southern portion of the property to receive sanitary services from the Clair Hills subdivision to the east (extension of sewer at intersection of Columbia Street and St. Moritz).	2024
18	Block 37	Carriage Cross (Blk 37)	Sanitary services to be extended as part of the servicing of subdivision 30T-08401.	2029
19	Block 38	Carriage Cross (Blk 38)	Sanitary services to be extended as part of the servicing of subdivision 30T-08401.	2029
20	110 Erb Street West	The Barrelyards	Sanitary servicing to development available.	2019
21	515 Erbsville Road	Howald	Sanitary servicing to development available.	2024
22	449 Brentcliffe Drive	Auerbach	Sanitary servicing to development available.	2029
23	480 Wilmot Line	Karges	Sanitary services to be extended from 30T-97024 (Parcel ID 2).	2024
24	290 & 294 Bridge Street West	Allenby Court	Sanitary servicing to development available.	2019
25		West Side Employment Lands (North)	Sanitary servicing to be extended from the employment/commercial lands to the south (Parcel ID 26)	2029
26	930 Erb Street West	West Side Employment Lands (South)	Sanitary servicing to be extended from the west.	2029
27	2001 University Avenue East	Rural East (City)	Extend 200 mm sanitary sewer on University Avenue.	2029

Parcel ID	Location		Description of Development Parcel Sanitary Servicing	Year Expected to be Completed
	Street Address	Development Name		
28	Conservation Drive/ Roy Schmidt Road	Activa (Conservation)	Services to be extended from Beaver Creek Road when available.	2024
29	720 Erbsville Road	Simpson	Sanitary services to be extended northward on Erbsville Road.	2029
30	665 Erbsville Road	Michaels	Sanitary services to be extended northward on Erbsville Road.	2029
31	576 Conservation Drive	Eperjesi	Sanitary services to be extended northward on Beaver Creek Road.	2029
32	556 & 560 Conservation Drive	Cook Homes (Conservation)	Sanitary services to be extended northward on Beaver Creek Road.	2029
33	Southwest corner of Beaver Creek Road	Groff (Conservation - 1)	Sanitary services to be extended northward on Beaver Creek Road.	2029
34	and Conservation Drive	Groff (Conservation - 2)	Sanitary services to be extended through adjacent lands.	2029
35	624 Conservation Drive	Brohman	Sanitary services to be extended westward on Conservation Drive.	2029
36	675 Conservation Drive	Go Cart	Sanitary services to be extended westward on Conservation Drive.	2029
37	Northeast corner of Conservation/ Erbsville	Hexagon	Sanitary alignment to the lands to be determined through a servicing analysis.	2029
38	795 Erbsville Road	Activa (Erbsville)	Sanitary to be extended by developer from Conservation Drive.	2029
39	1021 Bisch Street	Zister	Sanitary to be extended by developer from Conservation Drive.	2029
40	East of University Ave, South of Wismer Street, West of Pelham Street		These properties may be services to Falconridge SPS in the City of Kitchener.	2029
41	Maverick Street		Properties are to be serviced by the existing sewers adjacent to the properties; flows will drain into to the Falconridge SPS in the City of Kitchener.	2029
42	University Avenue East at Wismer Street		Property to be services by the existing sewer along University Ave East, flows will drain into to the Falconridge SPS in the City of Kitchener.	2029

Parcel ID	Location		Description of Development Parcel Sanitary Servicing	Year Expected to be Completed
	Street Address	Development Name		
43	University Ave East at New Bedford Drive		Properties are to be serviced by the existing sewers adjacent to the properties. Flows will drain into the Eastbridge catchment area, upstream of the Colonial SPS.	2029
44	Grey Silo Rd		Sanitary services to be extended along Grey Silo Road, flows will drain into Millenium SPS.	2029
45	Grey Silo Rd		A grinder pump is required to service the property. Flows to be directed to Millenium SPS.	2029
46	Grey Silo Rd		Sanitary Services to be extended north from Grey Silo Road. Flows will drain into the Eastbridge catchment area, upstream of the Colonial SPS.	2029
47	Paris Boulevard		Properties are to be serviced by the existing sewers adjacent to the properties. Flows will drain into the Cedar Trunk along Brandenburg Boulevard.	2029
48	Erb Street, West of Ira Needles		These properties are to be services by a trunk sewer required from Montpellier Drive, these flows will drain into the Lower Cedar Trunk.	2029
49	St. Moritz Avenue/Interlaken Drive/ Atheim Crescent		Properties are to be serviced by the existing sewers adjacent to the properties. Flows will drain into the Middle-Cedar Trunk.	2029
50	Wideman Road/ Laurelwood Drive		Properties are to be serviced by the existing sewers adjacent to the properties. Sanitary sewers will connect to Meadowsweet Avenue and flows will drain into the Upper Cedar Trunk.	2029
51	Meadowsweet Avenue		Sanitary sewers will connect to Meadowsweet Avenue and flows will drain into the Upper Cedar Trunk.	2029
52	Conservation Drive		Property to be services by the existing services north from Conservation Drive, upon completion of servicing to the Beaver Creek Development Area.	2029

Parcel ID	Location		Description of Development Parcel Sanitary Servicing	Year Expected to be Completed
	Street Address	Development Name		
53	Conservation Drive		Property to be services by the existing services north from Conservation Drive, upon completion of servicing to the Beaver Creek Development Area.	2029
54	Conservation Drive		Property to be services by the existing services north from Conservation Drive, upon completion of servicing to the Beaver Creek Development Area.	2029
55	Pinery Trail/ Rideau River Street/ Wasaga Crescent		Development is underway, sanitary servicing will be connected to existing sewer adjacent to the properties, and flows will drain into the Upper Forwell Trunk.	2029
56	Beaver Creek Road and Conservation Drive		To be serviced along Beaver Creek Road once infrastructure is in place to service the Beaver Creek development area.	2029
57	Laurelwood Drive and Bearinger Road		To be serviced by existing services along Laurelwood Drive, flows will drain into Beaver Creek SPS.	2029
58	University of Waterloo North Campus		A grinder pump will be required for this property due to elevations. Sanitary servicing will be connected to the existing services southwest of the property, and flows will drain south along Westmount Road, and ultimately into the Laurel Trunk.	2029
59	Regal Place		Properties to be serviced by infrastructure adjacent to the properties along Regal Place. Flows will be directed south to the Upper Cedar Trunk, and will ultimately flow into the Beaver Creek SPS.	2029
60	Werni Court		Properties to be serviced by existing infrastructure adjacent to the properties. The flows will drain into the Upper Cedar Trunk via Cedar Bend Drive.	2029
61	Westvale (northwest corner)		Properties to be serviced by existing infrastructure adjacent to the properties. Flows will drain through the Westvale Area and ultimately into the Maple Trunk along University Avenue West.	2029

5.1.2 Infill and Intensification Development

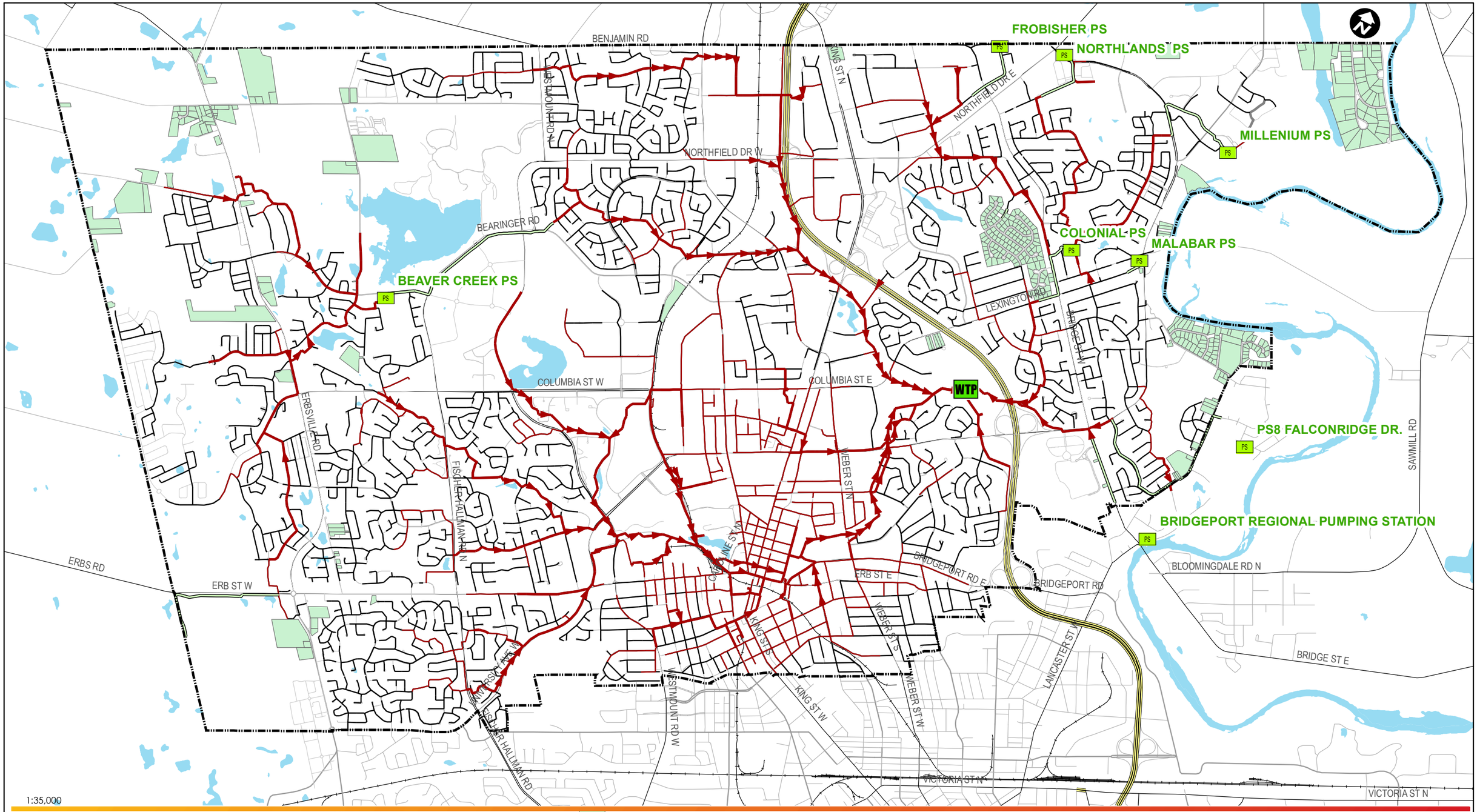
Infill and intensification will occur throughout the City as existing areas are redeveloped with higher population densities. The area projected to experience the most significant infill and intensification is in the vicinity of Uptown Waterloo within the planning area referred to as the Core Area. Servicing to the areas of redevelopment will be provided primarily through existing infrastructure, with upgrades to be completed as necessary to increase capacity.

5.1.3 Municipal Servicing for Existing Private Services

Although the majority of the City is serviced through municipal infrastructure, there are some areas that currently have private sanitary services. Through coordination with the City, 359 properties were identified as having private services, as shown in Figure 5-2. Of these properties, 244 are associated with non-zero water records (i.e. they have municipal water services and private sanitary services). These properties were assigned flows during the model development phase of the project as the loading was allocated based on water metering (refer to Tech Memo 6 for details). The remaining 115 properties were categorized by land use and flows were assigned based on population densities, per capita rates, and I/I allowances specified in the following sources:

- DGSSMS (Region of Waterloo, 2015)
- Design Guidelines for Sewage Works (Ministry of the Environment (MOE), 2008)
- District Plans (City of Waterloo, 2013)

Additional details regarding the allocation of flows to these properties can be found in Appendix A.



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Legend

- CityBoundary
- Water Body
- Forcemain
- PS Existing Pump Station
- WTP Wastewater Treatment Plant

All Sanitary Sewers
- Local Sewers
- Trunk Sewers

Model Selection Set
- Local Sewers
- Trunk Sewers

Properties on Septic

Figure No. FIGURE 5-2

Title **CURRENT PROPERTIES SERVICED BY SEPTIC SYSTEMS**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE

5.2 IDENTIFICATION OF CAPACITY CONSTRAINTS AND GROWTH OPPORTUNITIES

5.2.1 Growth Opportunities

Areas within the City indicating significant greenfield development are located in the north-west and western areas of the City, and are referred to as Beaver Creek (refer to Parcel IDs 28, 29, 31-39 in Figure 5-1) and West Waterloo (refer to Parcel IDs 2-4,17, 23 in Figure 5-1), respectively. Servicing to West Waterloo was previously identified by extending a trunk sewer from Columbia Forest Court (referred to as Cedar Trunk 2 (West) Extension) through ESPA 19 in accordance with *West Side Trunk Sanitary Sewer - South Branch Class EA* (1996) and *City Wide Sanitary Sewer System Update Master Plan Class EA* (AECOM, 2002). This trunk extension was installed between 2007 and 2013 and additional servicing required to accommodate growth would be associated with the construction of local sewers. Development within Beaver Creek is to be provided through the construction of new trunk sewers and two new sanitary pump stations. The *Conservation Drive and Beaver Creek Road Upgrades and Extension of Municipal Services Class EA* (Stantec, ongoing) is currently in progress to confirm the location of proposed infrastructure.

Properties currently provided with private sanitary servicing were also reviewed to evaluate the feasibility of providing municipal servicing. Municipal servicing could be provided to the majority of these parcels through an extension of local sewers and conveying flows by gravity. However some properties cannot be serviced by gravity and will require a pump station or grinder pump. These servicing strategies are discussed in greater detail in Section 6.2.3.

It can be noted that several properties on private sanitary services are located in the Beaver Creek development area. As part of the extension of municipal services to accommodate proposed development, upgrades could be coordinated to provide municipal servicing to existing residents at the same time.

5.2.2 Capacity Constraints

Evaluating the capacity of existing infrastructure to accommodate proposed growth was completed using the hydraulic model. As noted in future scenario modelling results (refer to TM 6 and Section 4), the following constraints have been identified:

- Maple Hill Trunk in the easement between Westvale Drive and Fischer-Hallman Road
- Downstream of Frobisher PS
- Downstream of Beaver Creek

Alternatives to address these constraints are further discussed in the following section.

6.0 IDENTIFICATION AND EVALUATION OF ALTERNATIVES

6.1 IDENTIFICATION OF ALTERNATIVES

6.1.1 Servicing to Greenfield Development

Municipal servicing to the Greenfield development areas has been identified in the *City of Waterloo Staging and Development Report for 2011-2014* (2011). The Greenfield development area parcels were identified in Figure 5-1 and the preferred servicing alternatives were outlined in Table 5-1.

Sewage loadings of the identified Greenfield development areas were incorporated into the future model scenarios developed in Tech Memo 6 to include the impact of providing municipal servicing to these areas. The capacity constraints resulting from the current and future modeled scenarios are captured in Section 6.1.3. It can be noted that municipal servicing has already been identified for the Greenfield development areas identified in Table 5-1, and these strategies are recommended to be carried forward as outlined without further evaluation at the master planning level of analysis.

6.1.2 Servicing for Existing Private Services

As discussed in Section 5.1.4, total of 359 properties have been identified which are currently are not connected to municipal sanitary servicing and are serviced privately by septic systems. These parcels have been grouped into 31 areas based on serviceability; refer to Figure 6-1.

Servicing alternatives have been identified for these properties; refer to Section 6.2.3.1. The properties were grouped into three (3) categories based on land use type and proximity to Wellhead Protection Sensitivity Areas. Refer to Figure 6-2 for additional details:

1. The first category includes within the Wellhead Protection Sensitivity Area 8, which delineates the area outside of the *10 year time of travel* to the limit of the total land area contributing water to a municipal drinking-water. This group includes the following land-uses: consisting of agricultural, recreational/commercial, institutional, and residential land use.

2. The second category includes properties which are outside of the wellhead protection areas. This group includes the following land-uses: consisting of agricultural, recreational/ commercial, institutional, and residential land use.

3. The third category has been assigned to Industrial/Commercial properties because the waste generation for these types of properties can range dramatically in quantity and quality from site to site.

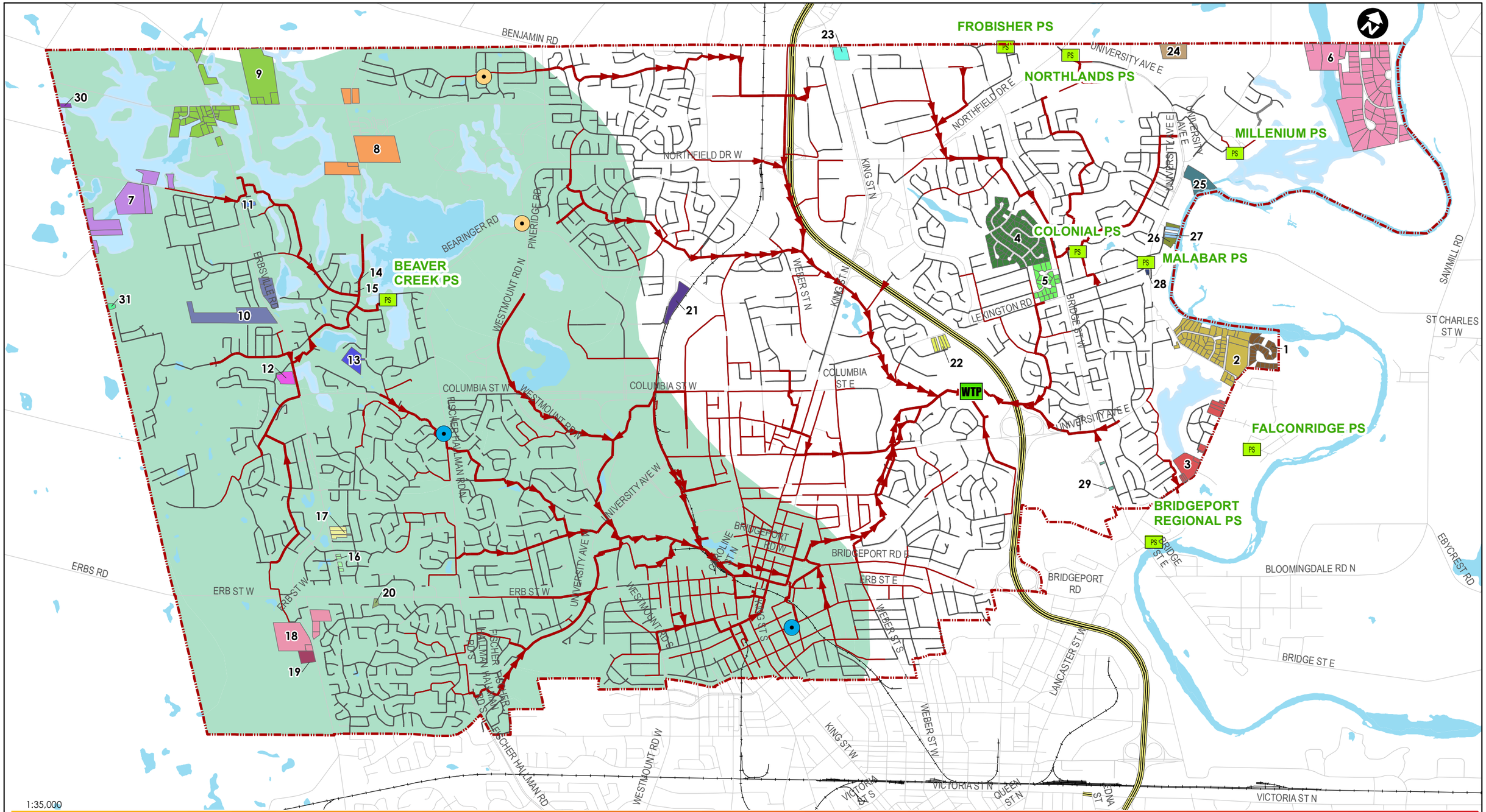
Each category will be evaluated as a distinct alternative for A) remaining privately serviced ("Do Nothing") and B) providing municipal servicing. Refer to Table 6-1.

Sewage loadings have been developed for each property, and a model simulation has been developed to evaluate the impact of providing municipal servicing to existing private services. Based on this preliminary analysis, additional capacity constraints have been identified along the Forwell Trunk, and downstream of Frobisher SPS. These locations have already been identified as having capacity constraints based on the growth scenarios, but the capacity constraints are more significant when flows from the properties on septic are included.

Cost sharing for municipal servicing will be detailed in Section 10.

Table 6-1: Servicing Alternatives for Existing Private Services

Category Description		Alternatives		Required Upgrades
1	Properties within Wellhead Protection Sensitivity Areas (16 parcel groups)	A	Do Nothing	No Upgrades Required
		B	Provide Municipal Servicing	Upgrades along the Cedar Trunk(receiving sewers of the Beaver Creek SPS)
2	Properties Outside Wellhead Protection Sensitivity Areas (14 parcel groups)	A	Do Nothing	No Upgrades Required
		B	Provide Municipal Servicing	Upgrades to receiving sewers of Frobisher SPS
3	Industrial and Commercial Properties (1 parcel groups)	A	Do Nothing	No Upgrades Required
		B	Provide Municipal Servicing	No Upgrades Required



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Legend

- Well
- Test Well
- Wellhead Protection Area 8
- Existing Properties on Private Services
- PS Existing Pump Station
- WTP Wastewater Treatment Plant

All Sanitary Sewers
- Local Sewers
- Trunk Sewers

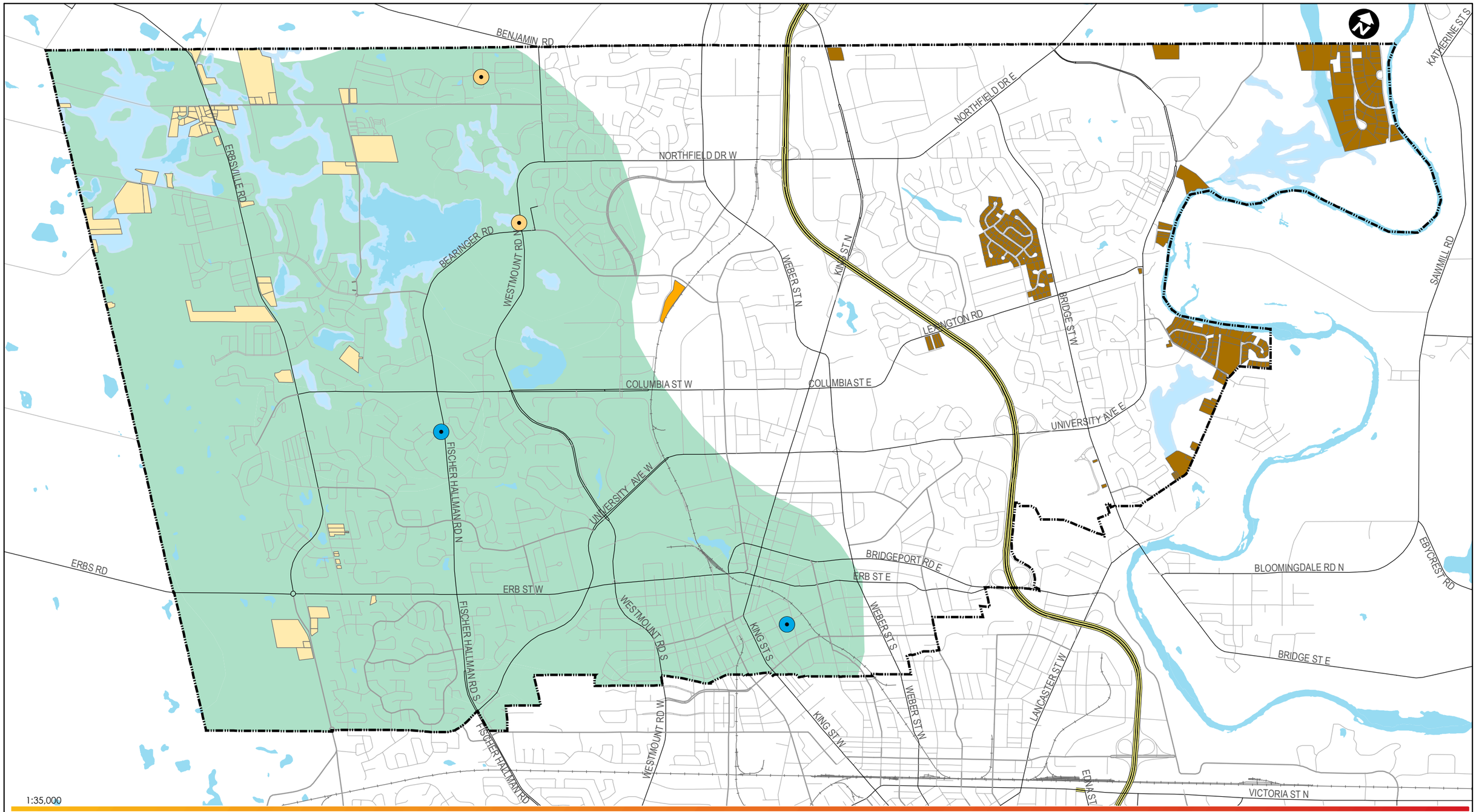
Model Selection Set
- Local Sewers
- Trunk Sewers

- CityBoundary
- Wetlands
- Water Body

Figure No. FIGURE 6-1

Title **CURRENT PROPERTIES SERVICED BY SEPTIC SYSTEMS (GROUPED BY SERVICEABILITY)**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE



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Legend

- Well
- Test Well
- Wellhead Protection Area 8
- Highway
- Arterial Road
- Collector Road
- Local Road
- Railroad
- CityBoundary
- Water Body

Septic Properties

- Category 1
- Category 2
- Category 3

Figure No. FIGURE 6.2

Title **CURRENT PROPERTIES SERVICED BY SEPTIC SYSTEMS (CATEGORIES)**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE

6.1.3 System Capacity Constraints

Constraints identified during the modelling of the future growth scenarios include the following areas:

4. Maple Hill Trunk.
5. Downstream of Frobisher PS.
6. Downstream of Beaver Creek.

A drawing review was conducted at the location of each constraint to allow utility conflicts to be avoided during the development of servicing alternatives. The Procedure F-6-1 published by the MOE in 2014 requires watermain are to be aligned with a minimum horizontal separation from sanitary sewers of 2.5 m. Alternative solutions for addressing the identified capacity constraints are presented in the following sections.

6.1.3.1 Maple Hill Trunk

Capacity constraints have been identified for Maple Hill Trunk under existing and future model conditions, and as such alternatives have been generated to address this constraint. During the drawing review of the Maple Hill Trunk at the location of the capacity constraint, discrepancies were identified between the construction drawings and the model geodatabase. The discrepancies included the inverts of the two (2) sewer pipes upstream of the capacity constraint. During the initial geodatabase verification phase, a drawing review was not warranted in this area, and therefore this discrepancy was not identified at that time.

The location of the capacity constraint along the Maple Hill Trunk is in an existing easement. Therefore, the 'Do Nothing' alternative may be a viable solution if there are no service connections within this area, and the risk of basement flooding is low. The easement is 6 m (20 ft) wide. Due to the alignment of the existing sanitary sewer, there is limited space available within the existing easement for twinning on either side of the existing sewer. The sewers at the location of the capacity constraint could be replaced along the existing alignment to improve hydraulic capacity through the sewer section. Upgrades to this section which would improve the hydraulic capacity could include increasing the size of pipe, or the slope of the pipe. A fourth alternative would be to adjust the operation of the upstream weir (overflow structure) to divert flows along an alternate route and potentially utilize available capacity.

The alternatives for addressing the capacity constraint in the Maple Hill Trunk are summarized in Table 6-2.

Table 6-2: Maple Hill Trunk Alternatives to Address Capacity Constraints

Description		Alternatives	
4	Maple Hill Trunk Capacity	A	Do Nothing
		B	Twin Sewers at Location of Capacity Constraint
		C	Replace Sewers at Location of Capacity Constraint
		D	Divert Flow

6.1.3.2 Downstream of Frobisher SPS

Capacity constraints have been identified downstream of the Frobisher SPS under existing and future model conditions, and as such alternatives were generated to address this constraint. Follow-up has been recommended to confirm the pump curves at this station as the downstream constraint is related to the operating capacity of the Frobisher pump being greater than the capacity of the sewers.

A drawing review was conducted to avoid potential utility conflicts. Given the available separation from nearby utilities, the hydraulic capacity through this section of sewer could be increased by twinning the existing sewer. Alternatively, the hydraulic capacity could be increased by replacing the sewers along the existing alignment. Upgrades to this section which would improve the hydraulic capacity could include increasing the size of pipe, or the slope of the pipe. This alternative would require bypass pumping.

The alternatives for addressing the capacity constraint downstream of Frobisher SPS are summarized in Table 6-3.

Table 6-3: Downstream of Frobisher SPS Alternatives to Address Capacity Constraints

Description		Alternatives	
5	Downstream of Frobisher SPS Capacity	A	Do Nothing
		B	Twin Sewer at Location of Capacity Constraint
		C	Replace Sewers at Location of Capacity Constraint

6.1.3.3 Downstream of Beaver Creek SPS

Capacity constraints have been identified downstream of the Beaver Creek SPS as a result of future growth in the upstream catchment areas, and as such alternatives were generated to address this constraint.

During the drawing review of the receiving sewers downstream of the Beaver Creek SPS a discrepancy in diameter was identified between the geodatabase carried in the model, and the Construction Drawings (Dated 1969). During the initial geodatabase verification phase, a drawing review was not warranted in this area, and therefore this discrepancy was not identified at that time. Table 6-4 provides a summary of the watermains where a discrepancy in diameter was noted.

Table 6-4: Watermains Downstream of Beaver Creek SPS Indicating a Discrepancy in Diameter

MX Asset ID	Diameter (mm)	
	Geodatabase (Model)	Construction Drawings
4772	600	825
5461	600	825
4764	600	825

The model was updated to incorporate the increased sewer diameter of 825 mm, as per the construction drawings. With this diameter, the receiving sewers have the capacity to conduct the anticipated flows from the Beaver Creek SPS based on the 2029 growth scenario.

6.1.3.4 Lower Forwell Trunk

Although the Lower Forwell Trunk was not identified as a constraint based on the 2029 growth scenario in Section 4.2, additional stress is observed along the Lower Forwell Trunk when properties currently on septic systems are connected to the sanitary network. Therefore, this area is identified as a capacity constraint, and alternatives have been identified below. It should be noted that the model encountered computational instability at t along the Lower Forwell Trunk, as discussed in Section 4.2.

The alternatives for addressing the capacity constraint along the Lower Forwell Trunk are summarized in Table 6-5. This upgrade would only be triggered in the event that the municipal servicing is provided to the existing properties on private services, specifically the properties in Category 1 (within Wellhead Protection Sensitivity Areas), as many of these properties are upstream of the Lower Forwell Trunk.

Table 6-5: Lower Forwell Trunk Alternatives to Address Capacity Constraints

Description		Alternatives	
6	Lower Forwell Trunk	A	Do Nothing
		B	Twin Sewer at Location of Capacity Constraint
		C	Replace Sewers at Location of Capacity Constraint

6.2 EVALUATION OF ALTERNATIVES

6.2.1 Methodology

The recommended servicing alternatives presented in Section 6.1 were evaluated and ranked based on a set of evaluation criteria. The evaluation criteria guided the assessment of servicing alternatives based on their impacts to the natural, social, and economic environments. The evaluation criteria are presented in the following section, Section 6.2.2. Table 6-6 outlines the ranking scale for criteria with good to poor range.

Table 6-6: Criteria Ranking Scale

Rating	Criteria Ranking	Numeric Score
Good		1.0
		0.75
Neutral		0.50
		0.25
Poor		0

The criteria are all weighted equally. Based on the ranking of the alternatives, the final score in combination with the growth considerations was used to select the preferred alternatives and prioritize implementation of projects.

6.2.2 Evaluation Criteria

The selection of the evaluation criteria were informed by the 2002 MP and the Municipal Class Environmental Assessment guidance document, and were finalized through consensus with the City of Waterloo Project Team. Table 6-7 outlines the criteria used for the evaluation of the recommended servicing alternatives.

Table 6-7: Evaluation Criteria

Category	Criteria	Description
Technical	Hydraulic Improvements	Ability for the alternative to provide an improvement to long term hydraulic constraints.
	Operations and Maintenance	Ranking of ongoing equipment operations and maintenance (pumps stations) versus collections upgrades (pipes).
	System Resiliency	Ability for upgrade to provide level of service under wet weather conditions.
Ease of Implementation	Constructability	Ease of construction for upgrades.
	Regulatory Considerations	Ease of obtaining the necessary regulatory approvals and Source Water Protection requirements.
Social	Impact for Surrounding Residents	Proximity to residents that may be impacted by noise, construction activities, and increased traffic.
System Suitability	Consistency with Planned Upgrades	Potential to coordinate with other planned works (roads, etc.) and achieve multiple planning objectives.
	Consistency with Operating Strategies	Ability for alternative to align with current operational practices.
Environment/ Sustainability	Carbon Footprint	Ability for alternative to minimize the carbon footprint of works (relining existing pipes vs addition of new pipes).
	Impact on Terrestrial/ Aquatic Systems	Potential for and/or severity of impacts to terrestrial and/or aquatic systems based on alignment (pipe) or footprint (pump station).
Financial	Capital Cost	Capital cost to implement the proposed alternative.
	Operating and Maintenance Cost	Cost to operate and maintain the proposed alternative over its lifecycle.

6.2.3 Results of Evaluating Alternatives

6.2.3.1 Municipal Servicing of Private Connections

The results of the evaluation of alternatives identified in Section 6.1.2 are presented in detail in Appendix B. Table 6-8 presents the results of the evaluation.

The results of the evaluation indicate that it would be beneficial to transfer all existing privately serviced sites to municipal servicing. The priorities for providing municipal servicing are based on the results of the ranking and are provided below:

1. Category 3: Industrial/Commercial Properties
2. Category 1: Properties within Wellhead Protection Areas
3. Category 2: Properties outside Wellhead Protection Areas

Table 6-9 provides an individual parcel review outlining the servicing recommendations based on the categorical priority ranking. Refer to Figure 6-1 for spatial reference.

Table 6-8: Detailed Evaluation of Alternatives for Private Servicing Categories

Ranking

Good Neutral Poor

Ranking			Servicing Alternative					
			1. Within Wellhead Protection Areas		2. Outside Wellhead Protection Areas		3. Industrial/Commercial Properties	
			1A	1B	2A	2B	3A	3B
Category	**Criteria**	**Weight**	Do Nothing	Municipal Servicing	Do Nothing	Municipal Servicing	Do Nothing	Municipal Servicing
Technical	Hydraulic Improvements	1						
	Operations and Maintenance	1						
	System Resiliency	1						
Ease of Implementation	Constructability	1						
	Regulatory Considerations	1	-	-	-	-	-	-
Social	Impact for Surrounding Residents	1						
System Suitability	Consistency with Planned Upgrades	1						
	Consistency with Operating Strategies	1						
Environment/ Sustainability	Carbon Footprint	1						
	Impact on Terrestrial/ Aquatic Systems	1						
Financial	Capital Cost	1						
	Operating and Maintenance Cost	1						
Total Score			5 1/2	6	5 1/2	5 3/4	5 1/2	6 1/4

Table 6-9: Individual Parcel Review

Grouping	Description	Servicing Strategy
Priority 1: Industrial/Commercial Properties		
21	University of Waterloo R&T Park	This parcel can be serviced by the existing local gravity sewer along Wes Gram Way and the Laurel Trail.
Priority 2: Properties inside Wellhead Protection Areas		
7	Beavercreek - Wideman	Not serviceable by gravity, therefore an SPS would be required. This parcel group is within Environmentally Sensitive Area, therefore this area will not be developed further, and municipal servicing is not recommended at this time.
8	Beaver Creek (1)	Servicing to this area will require an SPS and forcemain. Due to proposed development in this area, servicing to this area is currently in design. Therefore it is recommended municipal servicing be provided to these properties only once the required infrastructure is in place.
9	Beaver Creek (2)	Servicing to this area will require an SPS and forcemain. Due to proposed development in this area, servicing to this area is currently in design. Therefore it is recommended municipal servicing be provided to these properties only once the required infrastructure is in place.
10	Erbsville Rd at Laurelwood Dr	This parcel group can be serviced by gravity to the local sewer at White Elm Blvd and Erbsville Rd.
11	Wideman Rd at Erbsville Rd	This parcel can be serviced by gravity. Extend existing service along Werni Crt.
12	Erbsville Rd, north of Columbia Street W	This parcel can be serviced by gravity to adjacent trunk sewer along Erbsville Rd.
13	Brentcliffe Drive	This parcel can be serviced by gravity with a sewer extension along Brentcliffe Dr.
14	Beaver Creek Rd	This parcel can be serviced by gravity to the adjacent trunk sewer along Beaver Creek Rd.
15	Beaver Creek Rd	This parcel can be serviced by gravity to the adjacent trunk sewer along Beaver Creek Rd.
16	Erbsville Crt	This parcel group can be serviced by gravity to the local sewer along Erbsville Crt.
17	Erbsville Road	This parcel group can be serviced by gravity by constructing a sewer along Erbsville Crt.
18	Erbsville Road	This parcel group can be serviced by gravity to the local sewer along Erbsville Rd.

Grouping	Description	Servicing Strategy
19	Erbsville Road	This parcel is not serviceable by gravity with the existing sewers. Therefore a grinder pump will be required.
20	Heather Hill	This parcel is serviceable by existing gravity along Heather Hill.
30	Conservation Drive	This property could be serviced upstream of Beaver Creek SPS with a gravity Trunk.
31	Autumn Willow Drive	This property could be serviced upstream of Beaver Creek SPS by connecting to the existing sewer along Autumn Willow Dr.
Priority 3: Properties outside of Wellhead Protection Areas		
1	Bridgeport/Falconridge - River Oak	Due to elevation, this area cannot be serviced by gravity. Either a sewage pumping station or a low pressure system with grinder pumps would be required to service this area due to Elevations. The flows from these properties would be directed into Falconridge SPS in the City of Kitchener.
2	Bridgeport/Falconridge - Woolwich St N	This area is serviceable by gravity to Falconridge SPS in the City of Kitchener along Hawkswood Dr. A trunk main extension would be required and local sewers through the subdivision.
3	Bridgeport/Falconridge	These parcels may be serviced by gravity to Falconridge PS via City of Kitchener sewers along Hawkswood Dr. These properties could not be serviced by the nearest gravity main draining to Bridgeport due to elevation restrictions.
4	Colonial Acres (1)	This area could be serviced by gravity to Lee Ave and Castlefield Dr (SW corner). Minimum cover of 2 meters is just achieved, therefore a further feasibility study should be conducted, and a Lift Station, or low pressure system with grinder pumps may be required.
5	Colonial Acres (2)	This section is serviceable to Wissler Rd, upstream of the Colonial PS.
6	Country Squire (1)	This area was not included in the ultimate build-out that Millennium SPS was designed for. Therefore Millennium SPS would not have the capacity to accept these flows, and a forcemain would be required to direct flows to Colonial SPS, or trunk upgrades would be required. Due to the required infrastructure upgrades, it is recommended that servicing be scheduled beyond the 2029 planning horizon.
22	Lexington Ct	This parcel group can be serviced by gravity to the existing sewer along Lexington, or along Dearborn Pl.
23	King St at Bridge St	This parcel can be serviced by gravity to the Trunk along Northland Rd.

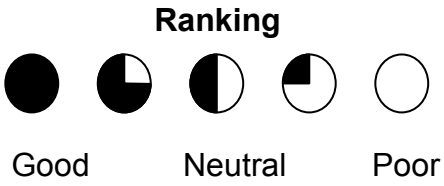
Grouping	Description	Servicing Strategy
24	County Squire (2)	This parcel can be serviced by gravity to the existing sewers along University Ave East. Flows can be diverted upstream of Millennium SPS.
25	Grand Bluffs at Eastbridge	This parcel cannot be serviced by gravity. Flows could be directed to Millennium PS using a Grinder Pump.
26	Woolwich Place (1)	This parcel group may require grinder pumps, as elevations do not permit gravity connections.
27	Woolwich Place (2)	This parcel group can be serviced to existing sewer adjacent to property. Flows may be directed to Malabar SPS.
28	Malabar Dr at Lexington Rd	This parcel can be connected to existing sewer in front of property, connection by gravity, upstream of Malabar SPS.
29	Bridgeport St near Bridal Trail	This parcel group can be serviced by the existing gravity main adjacent to property. This will drain into Bridgeport SPS.

6.2.3.2 Improving Maple Hill Trunk Capacity Constraint

The results of the evaluation of alternatives identified in Section 6.1.3.1 are presented in detail in Appendix B. Table 6-10 presents the results of the evaluation.

From Table 6-10, it can be seen that the top ranked alternative is 4D, divert flow along Westvale Drive/Fischer Hallman Road to the lower Maple Hill Trunk. This alternative allows residual capacity within the system to be utilized, the cost to reconfigure one manhole is expected to be less than the cost of twinning or replacing the length of pipe, this alternative does not require work within the narrow easement and therefore improves accessibility during construction.

Table 6-10: Detailed Evaluation of Maple Hill Trunk Alternatives



Ranking		Alternative			
		Maple Hill Trunk Capacity			
		4A	4B	4C	4D
Category	**Criteria**	Do Nothing	Twin Sewer Section	Replace Sewer Section	Divert Flow
Technical	Hydraulic Improvements				
	Operations and Maintenance				
	System Resiliency				
Ease of Implementation	Constructability				
	Regulatory Considerations				
Social	Impact for Surrounding Residents				
System Suitability	Consistency with Planned Upgrades				
	Consistency with Operating Strategies				
Environment/ Sustainability	Carbon Footprint				
	Impact on Terrestrial/ Aquatic Systems				
Financial	Capital Cost				
	Operating and Maintenance Cost				
Total Score		6	6 3/4	7 1/4	8 1/4

6.2.3.3 Improving Downstream Frobisher SPS Capacity Constraint

The results of the evaluation of alternatives identified in Section 6.1.3.2 are presented in detail in Appendix B. Table 6-11 presents the results of the evaluation.

From Table 6-11 it can be seen that the top ranked alternative is Alternative 5C. This is because it reduces operations and maintenance due to the removal of old infrastructure, and reduced risk of utility conflicts due to unchanged alignment.

6.2.3.4 Improving Lower Forwell Capacity Constraint

The results of the evaluation of alternatives identified in Section 6.1.3.3 are presented in detail in Appendix B. Table 6-12 presents the results of the evaluation.

From Table 6-12 it can be seen that the top ranked alternative is Alternative 6A which is the 'do nothing' alternative. This constraint is located through the Hillside Trail, adjacent to the WWTP. It is unlikely that surcharging in this area would cause basement flooding because there are no direct connections. The Hillside Trail is an environmentally sensitive area, and the 'do nothing' alternative avoids construction through this area.

Table 6-11: Detailed Evaluation of Downstream Frobisher SPS Alternatives

Ranking

Good Neutral Poor

Ranking		Alternative		
		Downstream of Frobisher SPS		
		5A	5B	5C
Category	**Criteria**	Do Nothing	Twin Sewer	Replace Sewer Section
Technical	Hydraulic Improvements			
	Operations and Maintenance			
	System Resiliency			
Ease of Implementation	Constructability			
	Regulatory Considerations	-	-	-
Social	Impact for Surrounding Residents			
System Suitability	Consistency with Planned Upgrades			
	Consistency with Operating Strategies			
Environment/ Sustainability	Carbon Footprint			
	Impact on Terrestrial/ Aquatic Systems			
Financial	Capital Cost			
	Operating and Maintenance Cost			
Total Score		5	5 3/4	6 3/4

Table 6-12: Detailed Evaluation of Lower Forwell Trunk Alternatives

Ranking

Good Neutral Poor

Ranking		Alternative		
		Lower Forwell Trunk		
		6A	6B	6C
Category	**Criteria**	Do Nothing	Twin Sewer	Replace Sewer Section
Technical	Hydraulic Improvements			
	Operations and Maintenance			
	System Resiliency			
Ease of Implementation	Constructability			
	Regulatory Considerations			
Social	Impact for Surrounding Residents			
System Suitability	Consistency with Planned Upgrades			
	Consistency with Operating Strategies			
Environment/ Sustainability	Carbon Footprint			
	Impact on Terrestrial/ Aquatic Systems			
Financial	Capital Cost			
	Operating and Maintenance Cost			
Total Score		7 1/4	5 1/4	6

6.2.4 Opinion of Probable Cost of Alternatives

The preliminary opinion of probable cost has been developed for each of the servicing alternatives; these costs are presented in the subsections below. Unit costs have been established for each component of the servicing alternatives, these can be found in the Appendix C. A detailed breakdown of the costing for each alternative can be found in Appendix D.

6.2.4.1 Municipal Servicing of Private Connections

Preliminary costing has been established for providing municipal servicing to the properties currently on private services, Table 6-13. Costs have been developed individually for each priority group of properties. The servicing strategies include servicing by gravity sewer, sewage pumping station and forcemain, grinder pumps and low pressure servicing systems.

Table 6-13: Servicing Alternatives for Existing Private Services

Category Description		Alternatives		Costing
1	Properties within Wellhead Protection Sensitivity Areas (16 parcel groups)	A	Do Nothing	No Cost
		B	Provide Municipal Servicing	$132,000
2	Properties Outside Wellhead Protection Sensitivity Areas (14 parcel groups)	A	Do Nothing	No Cost
		B	Provide Municipal Servicing	$2,805,000
3	Industrial and Commercial Properties (1 parcel group)	A	Do Nothing	No Cost
		B	Provide Municipal Servicing	$9,644,000

Note: Costs have been rounded up to the next $1,000.

6.2.4.2 Improving Maple Hill Trunk Capacity Constraint

Preliminary costing has been established for each of the servicing solutions proposed for the Maple Hill Trunk capacity constraint, Table 6-14. The servicing strategies include 'do nothing', twinning and replacing the sewers along the Maple Hill Trunk, as well as reconfiguration of the overflow structure and manhole to divert flow along a new flow path.

Table 6-14: Maple Hill Trunk Alternatives to Address Capacity Constraints

Description		Alternatives		Costing
4	Maple Hill Trunk Capacity	A	Do Nothing	No Cost
		B	Twin Sewers at Location of Capacity Constraint	$222,000
		C	Replace Sewers at Location of Capacity Constraint	$281,000
		D	Divert Flow	$36,000

Note: Costs have been rounded up to the next $1,000.

6.2.4.3 Improving Downstream Frobisher SPS Capacity Constraint

Preliminary costing has been established for each of the servicing alternatives proposed for the Frobisher SPS capacity constraint, Table 6-15. The servicing strategies include 'do nothing', twinning and replacing the sewers along the Frobisher Drive.

Table 6-15: Downstream of Frobisher SPS Alternatives to Address Capacity Constraints

Description		Alternatives		Costing
5	Downstream of Frobisher SPS Capacity	A	Do Nothing	No Cost
		B	Twin Sewer at Location of Capacity Constraint	$125,000
		C	Replace Sewers at Location of Capacity Constraint	$164,000

6.2.4.4 Improving Lower Forwell Trunk Capacity Constraint

Preliminary costing has been established for each of the servicing alternatives proposed for the Lower Forwell Trunk capacity constraint, Table 6-16. The servicing strategies include 'do nothing', twinning and replacing the sewers along the lower Forwell Trunk.

Table 6-16: Lower Forwell Trunk Alternatives to Address Capacity Constraints

Description		Alternatives		Costing
6	Lower Forwell Trunk	A	Do Nothing	No Cost
		B	Twin Sewer at Location of Capacity Constraint	$354,000
		C	Replace Sewers at Location of Capacity Constraint	$448,000

7.0 I/I PROGRAM RECOMMENDATIONS

Inflow and Infiltration (I/I) into the sanitary system represents capacity demands for dry weather (ground water infiltration) and wet weather (inflow) conditions. Generally, reduction of I/I in the sanitary system represents an opportunity to increase capacity and defer the need for capital upgrades.

7.1 HISTORIC I/I MONITORING PROGRAMS

The City has undergone several I/I studies in the past to determine the collection system's overall performance. These studies include:

- Report on the Sanitary Sewer Flow Monitoring Program - 1993 (Gore & Storrie, 1994)
- Sanitary Sewer Flow Monitoring program - 1998, Eastbridge on the Grand and upper Beechwood Subdivisions (CRA, 1999)
- City Wide Sanitary Master Plan (EarthTech, 2002)
- Clair Sewershed I/I Pilot Project (Stantec, 2012)

Based on the review of these historical flow monitoring results, the areas with the highest reported I/I rates include University Trunk, the Cedar Trunk, and the William Trunk, and the Clair Trunk. These trunk mains were identified in the Gore & Storrie Report (1994) as having the most significant response to wet weather, and the highest total observed I/I over the course of the study period.

7.2 FUTURE FLOW MONITORING RECOMMENDATIONS

The current flow monitoring program has coverage across the entire City's sanitary network. However, Stantec recommends the relocation of various monitors to further target areas of aging infrastructure with suspected I/I including the downtown core, Cedar trunk and Clair trunk. The proposed locations for flow monitor deployment are listed below:

1. The Downtown Core: Multiple monitors are proposed in the Downtown Core to be analyzed for I/I to characterize wet weather responses within the system as part of the Optimization and Rehabilitation Program as detailed in the next section.

2. Clair trunk: Historically, I/I concerns have been identified along the Clair trunk. The current flow monitor (LRL-56) downstream of this area captures a large area, encompassing the Clair Sewershed. The Clair Sewershed Study was completed by Stantec in 2012, which was focused within the proposed area. During this study, it was noted that precipitation volumes were abnormally low therefore flows observed may not

have represented typical wet weather responses. It is therefore recommended that continued monitoring is required along the Clair Trunk.

3. Cedar Trunk: The Cedar trunk has been identified as observing extraneous flows in the 1994 Gore and Storrie Study. Additionally, the 2013 flow monitoring data indicates an increase in extraneous flows between the Laurelwood Trunk (LWD-6) and the Forwell Trunk (FWL-4A). Therefore it is recommended that a flow monitor be installed and a sub trunk connected to the Cedar trunk.

4. Forwell Trunk: The upper reaches of the Forwell trunk will be receiving (preferred connection is near Weber Street and Benjamin Road) sanitary flows from St. Jacobs after decommissioning of the St. Jacobs WWTP (est. 2022). It is recommended that four flow monitors be installed: just downstream of the proposed connection; immediately upstream of the Cedar Trunk connection; immediately downstream of the Cedar trunk connection; and close to the connection to the Laurel Trunk.

Further detail regarding the proposed I/I flow monitoring locations will be developed for the upcoming Technical Memorandum #5.

7.3 OPINION OF PROBABLE COST OF THE I/I MONITORING PROGRAM

Based on the recommended I/I program described in Section 7.2, preliminary costing has been provided for the flow monitoring based on typical unit rates:

- Installation and removal, including maintenance, of flow monitor: $4,000/unit per annum

- Purchase of new flow monitor: $4,200/unit
  (Includes data logger, sensor, cables, and installation)

The cost for Installation/Removal, and Maintenance visits are incurred annually, whereas the cost for the purchase of new flow monitors is expected to be incurred only in Year 1. Each planning period has a duration of 5 years, and the purchase of new monitors is only incurred in planning period 2014 to 2019.

Table 7-1: Opinion of Probable Cost for I/I Reduction Plan

Description	Unit Cost ($/unit)	Unit Quantity (No. of Units)	Capital Cost (Yr 1)[1]	Capital Cost (>Yr 1)	2014 to 2019 (5 years)[1]	2019 to 2024 (5 years)	2024 to 2029 (5 years)
Flow Monitor Operation	$4,000	8	$32,000	$32,000	$160,000	$160,000	$160,000
Purchase of new flow monitor[1]	$4,200	8	$33,600		$33,600		
Maintenance visits (Purchased Monitors)	$600	8	$4,800	$4,800	$24,000	$24,000	$24,000
I&I Reduction Plan Subtotal			**$65,600**	**$32,000**	**$194,000**[2]	**$160,000**	**$160,000**

Note 1: Purchase of new flow monitor is only incurred in year 1.
Note 2: Costs have been rounded up to the next $1,000.

8.0 OPTIMIZATION AND REHABILITATION PROGRAM RECOMMENDATIONS

In addition to capital upgrades, it is recommended that capital funds be allocated to the optimization and rehabilitation of existing sanitary infrastructure.

Pipe defects can cause blockages, sewage overflows and back-ups. Both infiltration and exfiltration of sewers through cracks and other defects can erode the soil and weaken the soil-pipe structure, therefore increasing risk of further deterioration. Exfiltration can also pose risks of groundwater contamination. (US EPA, 2012)

As infrastructure ages, rehabilitation efforts are required to maintain a level of service. These efforts may include repair, rehabilitation, and replacement of the sanitary network to extend the service life, and reduce system failures. A key component of any rehabilitation program is the definition, identification, and location of defects.

A program to undertake optimization and rehabilitation of older infrastructure in the core area of the City will provide a twofold benefit:

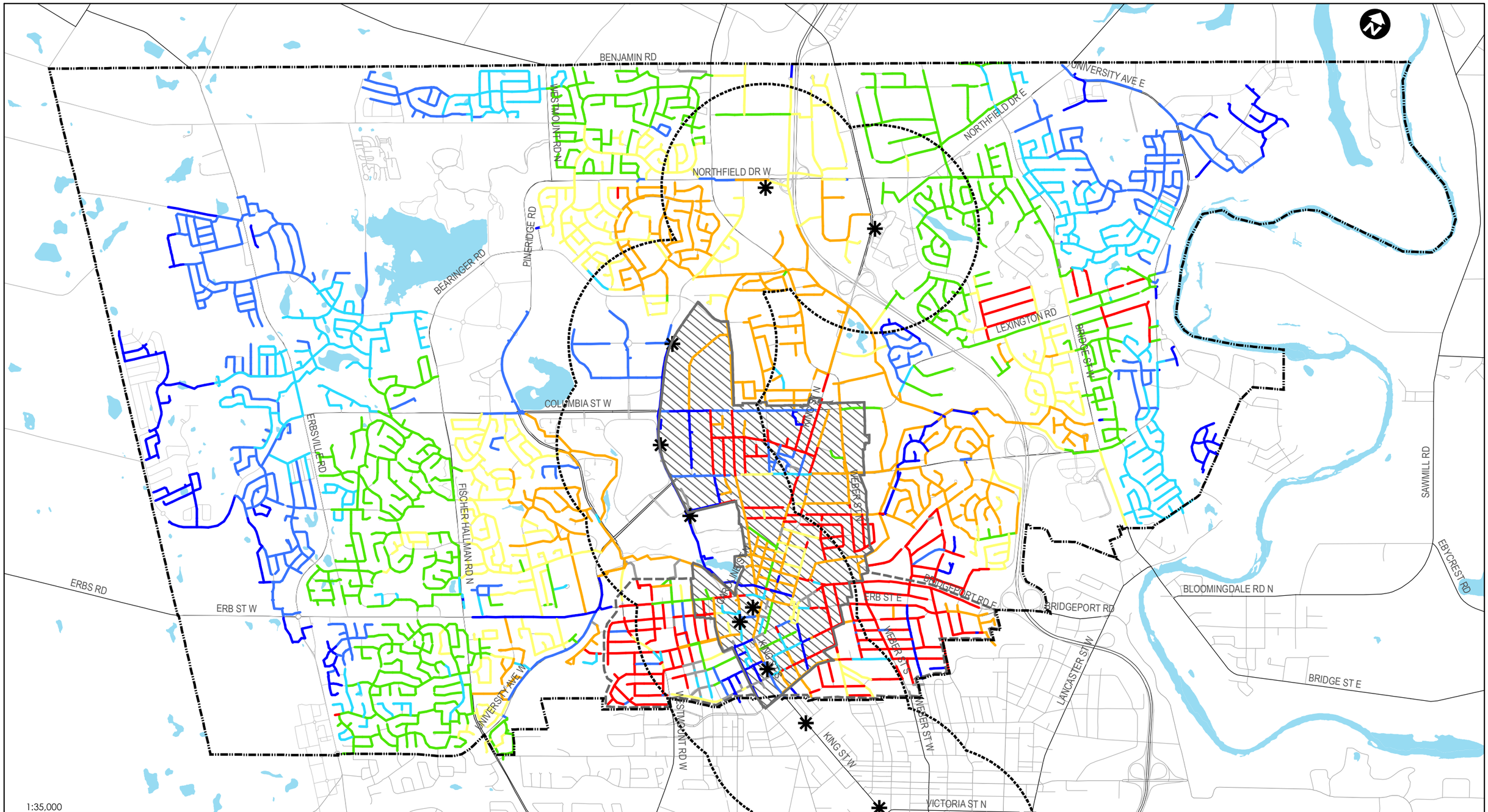
- Validate the condition of the core sanitary infrastructure for maintenance planning to extend the life of the assets.
- Enhance capacity of the core sanitary infrastructure to accommodate growth and intensification.

8.1 METHODOLOGY FOR PRIORITIZATION

The City currently employs a number of maintenance and rehabilitation strategies as part of best practice management of the sanitary system. However, as noted above, the focus of the optimization and rehabilitation program will be study and rehabilitation of the oldest areas of the sanitary system considering intensification and growth in the core and station areas.

Based on the size of the core area, it is not feasible to undertake rehabilitation throughout the core at the same time. As such, prioritization of areas is recommended based on the planned growth. Figure 8-1 shows the overlapping areas of:

- Areas with 1950-1960 pipe infrastructure.
- Areas with 1960 to 1970 pipe infrastructure.
- Core Area Study boundary.
- Station Areas.



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Legend

- CityBoundary
- Water Body

Sewer Install Date

- Unknown
- Before 1960
- 1960 - 1970
- 1971 - 1980
- 1981 - 1991
- 1992 - 1999
- 2000 - 2006
- 2007 - 2013

- Core Area Boundary
- Core Area - Aged Pipes
- Rapid Transit Area
- Rapid Transit Stations

1611-11191

Figure No. FIGURE 8-1

Title **AGE OF INFRASTRUCTURE AND PRIORITY CAPACITY NEEDS**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE

Areas with overlapping of three of the above areas have been designated as Optimization & Rehabilitation (O&R) Priority 1. This area is labelled as red on Figure 8-2.

Areas with overlapping of two of the above areas have been designated as O&R Priority 2. These areas are shown as orange on Figure 8-2.

The remaining areas are designated at O&R Priority 3. These areas are shown as yellow on Figure 8-2.

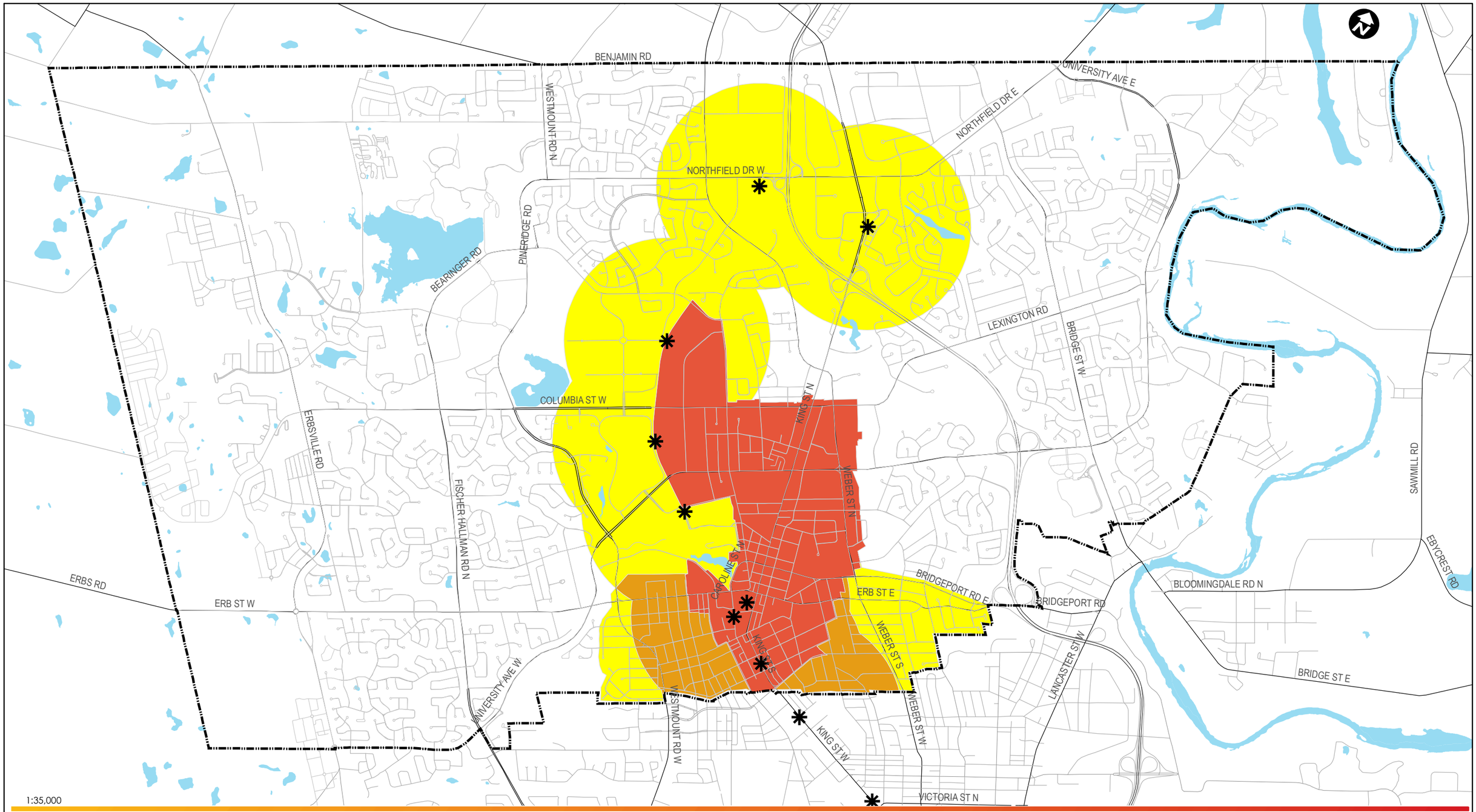
Within these areas, catchments will be identified for focus on the highest growth parcels and yield the maximum benefit for the allocated budget.

8.2 STUDY APPROACH TO DEFINE REHABILITATION NEEDS

The first step for rehabilitation is to identify the specific areas of concern, which may include aging infrastructure, sedimentation issues, I/I, or corrosion issues. The reduction of I/I is typically a focus for municipalities when treatment plant capacity is a constraint, as well as wet weather capacity constraints in the collection systems. These efforts often include leak detection exercises such as smoke testing, dye tracing, CCTV inspections, grouting, and relining of pipes. Elevated levels of inflow and infiltration, when combined with the impervious surfaces found in urban and suburban areas, reduces flows in streams, which can adversely affect aquatic ecosystems and reduce water availability (US EPA, 2007).

For each of the identified O&R Priority Areas and catchments, the following process (Figure 8-3) is recommended to validate information, verify performance and develop a rehabilitation plan. The same process will be repeated for each Priority area once the highest Priority targets have been optimized.

Using the results of these various preliminary I/I and condition investigations, various rehabilitation options should be considered. Section 8.3 outlines various sanitary sewer rehabilitation options which should be considered once specific deficiencies have been identified.



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Legend

- CityBoundary
- Water Body

Rehabilitation Areas

- Priority 1
- Priority 2
- Priority 3

Figure No. FIGURE 8-2

Title **OPTIMIZATION AND REHABILITATION PROGRAM PRIORITY AREAS**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE

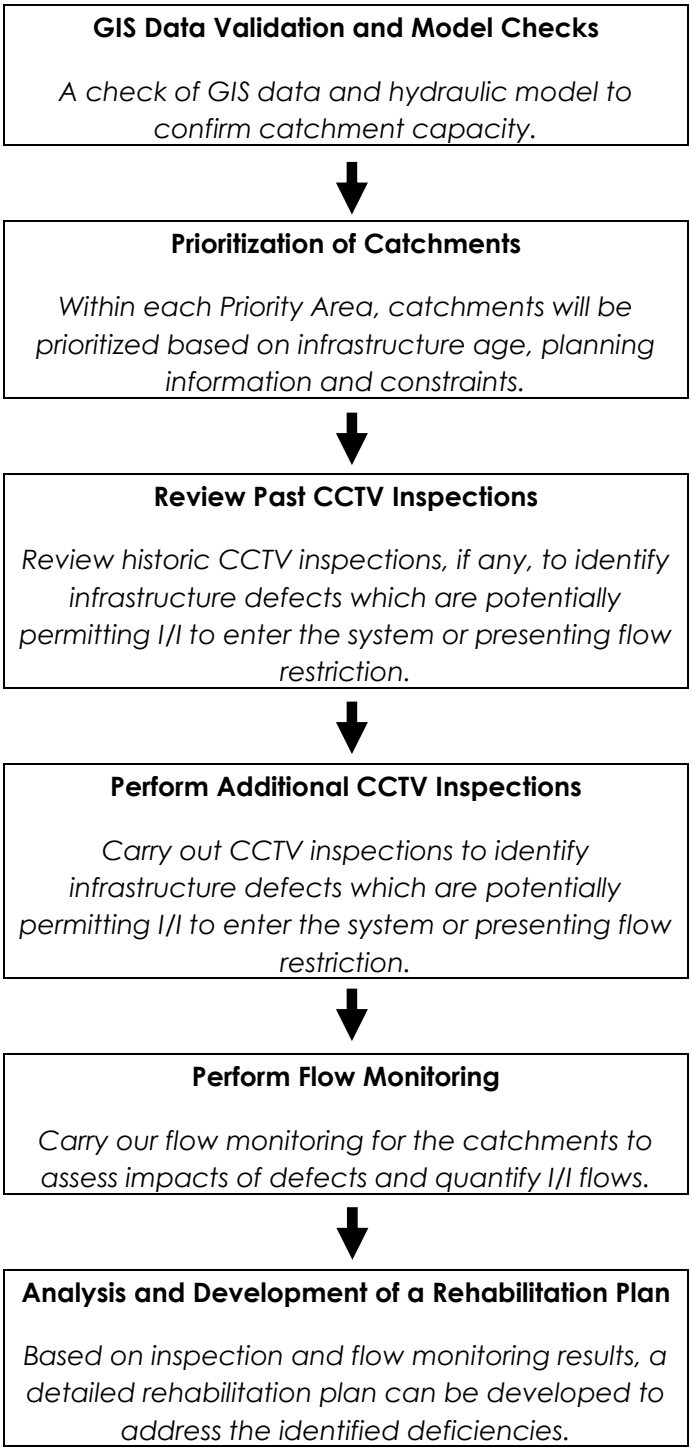
GIS Data Validation and Model Checks
A check of GIS data and hydraulic model to confirm catchment capacity.
Prioritization of Catchments
Within each Priority Area, catchments will be prioritized based on infrastructure age, planning information and constraints.
Review Past CCTV Inspections
Review historic CCTV inspections, if any, to identify infrastructure defects which are potentially permitting I/I to enter the system or presenting flow restriction.
Perform Additional CCTV Inspections
Carry out CCTV inspections to identify infrastructure defects which are potentially permitting I/I to enter the system or presenting flow restriction.
Perform Flow Monitoring
Carry our flow monitoring for the catchments to assess impacts of defects and quantify I/I flows.
Analysis and Development of a Rehabilitation Plan
Based on inspection and flow monitoring results, a detailed rehabilitation plan can be developed to address the identified deficiencies.

Figure 8-3: Study Approach to Define Rehabilitation Needs

8.3 SANITARY SYSTEM REHABILITATION OPTIONS

The following sections review rehabilitation options for pipes and manholes. The data validation, I/I monitoring and CCTV review will be used to identify deficiencies and provide refinement of approach to rehabilitation (pipes, manholes or both).

8.3.1 Sewer Relining

A remedial option for the identified deficiencies in both the main sewer and laterals is sewer relining. This method is commonly used for sewer rehabilitation as it causes minimal disturbance to the surrounding streets and services. Relining of sewers can be done in place without the need for excavation. Typical trenchless pipe lining technologies are described below.

8.3.1.1 Cured-in-Place Pipe (CIPP)

CIPP relining involves the installation of a jointless pipe within the existing pipe. This process involves the insertion of a resin-impregnated lining tube which is then cured to form a tight fit against the existing sewer. This type of technology uses the existing pipe to form a tight fit lining that prevents and stops deterioration of the original pipe and helps eliminate inflow issues from cracks and displaced joints. The intended applications of CIPP are for gravity pipelines between manholes, spot repairs, and lateral relining.

8.3.1.2 Sliplining

This relining method uses sections of a custom liner pipe, which are assembled inside the original sewer pipe by tunneling. These pipe sections are pushed inside the original pipe and the annular space is grouted. Typical liner pipe material used in sliplining is PVC or HDPE. Sliplining applications generally involve excavating an insertion pit and receiving pit for the liner pipe, and thus this relining method is used occasionally.

8.3.1.3 Chemical Grouting

Chemical grouting is typically used for spot repairs to seal identified open joints and non-structural cracks. This technique transforms the surrounding soil into a flexible and impermeable mass which is used to resolve leaky joints and small cracks in the sewer. This rehabilitation method does not provide structural repair to the pipe.

8.3.1.4 Comparison of Relining Options

There are various relining options for both the mainline sewer and sanitary laterals. Table 8-1 summarizes each of the options, including their advantages and disadvantages and approximate cost.

Table 8-1: Sewer Relining Options

Rehabilitation Technology	Advantages	Disadvantages	Typical Application	Cost (including cleaning/prep)
CIPP	• Quick installation with little excavation required • Can accommodate a variety of diameters • Widely available	• The existing pipe requires cleaning and preparation prior to application • Partial buckling and/or ovality may occur during installation	Can be used in all full structural, semi-structural, and non-structural rehabilitation scenarios	Mainline Sewer: $225/m or $15,000 per line of mainline sewer Lateral: $3,000 - $4,000 per lateral from external cleanout to mainline $4,000 - $6,000 per lateral from house to mainline
Sliplining	• Little disturbance to surrounding utilities and road services • Can be applied to most pipe types	• Reduction in diameter • Under short sections, increased cost can occur in the joining techniques	Most commonly used for full structural rehabilitation requirements	Mainline Sewer: $1,300/m
Chemical Grouting	• Cost effective method for fixing infiltration caused by leaky joints • Can prevent future structural damage	• Does not provide structural repair • Potential groundwater pollution can occur depending on the type of grout used • Cannot be performed for entire lateral length	Only used for non-structural deficiencies	Mainline Sewer: $1,500 per spot repair

8.3.2 Sewer Replacement

The alternate option to relining is to replace the existing sewers and/or laterals where deficiencies have been identified. Sewer replacement can be trenchless but often requires minor excavation and disturbance to the road and surrounding utilities. Possible replacement options are described below.

8.3.2.1 Open Cut

This option for sewer replacement requires trenching to install a new sewer in parallel to the existing or in place of the existing section. This option allows for a new sewer to be installed with a longer expected life than most trenchless technologies. Replacement allows for the realignment of the sewer (if required), new connections to uphold updated standards, and allows for the sewer capacity to be upgraded to meet current and future hydraulic requirements.

In comparison to relining, open cut sewer replacement is generally of significantly higher cost and causes disturbance to the surrounding area including roads and other utilities. Road restoration is typically required for this application, resulting in extended construction periods in comparison to other replacement and relining options.

8.3.2.2 Pipe Bursting

Pipe bursting is a replacement option that does not require trenching. This method replaces the sewer by breaking and displacing the existing pipe and installing a new pipe through a heavy duty pulling device. Although this method is more cost effective as it does not require major excavation, access to all sewer and lateral pipe connections is required.

8.3.2.3 Directional Drilling

This pipe replacement technique is completed in multiple stages where a pilot bore is initially made to create a hole at the required length and grade. A reamer is then pulled back to enlarge the hole to the required diameter, followed by the pull back of the new pipe through the bore. Similar to pipe bursting, this is a trenchless replacement technique which requires minimal disruption to the road services with little restoration cost. Drilling, however, is an expensive option and fissures (known as “frac-outs”) from the drilling mud are often created in the surrounding area.

8.3.2.4 Feasibility of Pipe Replacement

Due to the major monetary costs of excavation and the inherent disturbance to roadways and residents, open cut and directional drilling sewer replacement may not be feasible options for rehabilitating relatively minor deficiencies. The advantages and disadvantages of pipe bursting are summarized in Table 8-2, which includes the approximate cost of this sewer replacement method.

Table 8-2: Sewer Replacement with Pipe Bursting

Rehabilitation Technology	Advantages	Disadvantages	Typical Application	Cost (including cleaning/prep)
Pipe Bursting	• Does not require major excavation • New jointless pipe is impervious to roots and leakage • Existing pipe is not removed (no disposal costs)	• Requires minor excavation to create a pit for bursting pipe • Possible entry from household cleanout for lateral pipes	• Removal of pipe deficiencies through installation of new jointless pipe	Mainline Sewer and Lateral: - $6,500 - $7,000 per line

8.3.3 Manhole Rehabilitation

8.3.3.1 Plug Low Lying Manholes

In areas of low elevation, pooled water may accumulate around manholes during large rainfall events. To prevent extraneous rain flows from entering the sanitary system through manholes, the pick holes of manhole lids can be plugged. This option is particularly low-costing and simple to perform for manholes where pooling water is observed.

8.3.3.2 Manhole Resealing

In areas where inflow is noted for manholes, the cause is likely a result of water entering through frame seals that are in poor condition.

There are three primary rehabilitation options to reduce inflows in sanitary manholes:

- Resealing the frame seal with a waterproof cement mortar or flexible sealant, or
- Resealing the chimney with a rubber frame sleeve, or
- Installing a robust water-tight frame and cover system.

A brief description of these technologies, including advantages, disadvantages and estimated costing, is presented in Table 8-3.

Table 8-3: Manhole Rehabilitation Options

Rehabilitation Technology	Advantages	Disadvantages	Typical Application	Cost (incl. prep, install and rehab works)
Resealing (sealant)	• Does not require major preparation • Provides a new seal to prevent inflows from entering through cracks or poor joints	• Does not provide significant structural support • Does not prevent inflow from entering through manhole lid holes • Manhole must be completely dry • Subject to failure in extreme cold weather	Spray-and-seal or trowel application	$2,000/manhole
Resealing (sleeve)	• Provides a new seal to prevent inflows from entering through cracks or poor joints • Provides structural support to chimney and frame of manhole	• Requires custom build and sizing • Does not prevent inflow from entering through manhole lid holes	Installs new risers to the existing manhole	$3,000/manhole
Frame and Cover System	• Seals faulty joints and cracks in frame and chimney • Provides structural support to the frame, chimney, and surrounding asphalt • Prevents inflow through manhole pick holes	• Installation is more lengthy • More costly	Installs new framing and risers to the existing manhole New manhole cover	$3,300/manhole

8.4 OPINION OF PROBABLE COST OF THE OPTIMIZATION AND REHABILITATION PROGRAM

For budgetary purposes, a preliminary optimization and rehabilitation plan has been developed. This includes rehabilitation of sewers, laterals, and manholes within each priority area. As discussed in Sections 8.1, through 8.3, various rehabilitation methods are available. For costing purposes, the following unit prices have been used:

- Sewer Rehabilitation: $225/m (CIPP)
- Lateral Connection: $4,000/lateral
- Manhole Rehabilitation: $5,300/MH (Frame and Cover System & Reseal)

The cost estimates are shown in Table 8-3, broken down by priority group. The total quantities have been estimated for length of sewer, number of laterals, and number of manholes within each priority group. Laterals have been omitted from the Priority 1 Area because the development in this area is largely funded by private developers, and the cost of lateral replacement is likely to be incurred by the developer rather than the City. The rehabilitation works is assumed to cover a percentage the infrastructure within each priority group. A range of percentages has been provided to show the corresponding impact to costs.

Table 8-4: Manhole Rehabilitation Options

Priority 1 Area			17.5%		25%		32.5%	
	Units	**Unit Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**
Length of Pipe (m)	46,619	$225	8,158	$1,509,276	11,655	$2,156,109	15,151	$2,802,942
Manholes (ea.)	691	$5,300	121	$22,371	173	$31,959	225	$41,546
Total Cost[1]				**$1,532,000**		**$2,189,000**		**$2,845,000**
Priority 2 Area			17.5%		25%		32.5%	
	Units	**Unit Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**
Length of Pipe (m)	18,471	$225	3,232	$598,012	4,618	$854,303	6,003	$1,110,594
Lateral (ea.)	1,510	$4,000	264	$48,886	378	$69,838	491	$90,789
Manholes (ea.)	192	$5,300	34	$6,216	48	$8,880	62	$11,544
Total Cost[1]				**$654,000**		**$934,000**		**$1,213,000**
Priority 3 Area			10%		15%		20%	
	Units	**Unit Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**
Length of Pipe (m)	68,926	$225	6,893	$1,275,128	10,339	$1,912,691	517	$95,635
Lateral (ea.)	4,103	$4,000	410	$75,906	615	$113,858	31	$5,693
Manholes (ea.)	970	$5,300	97	$17,945	146	$26,918	7	$1,346
Total Cost[1]				**$1,369,000**		**$2,054,000**		**$103,000**

Note 1: These costs have been rounded up to the next $1,000.

9.0 PRELIMINARY PREFERRED ALTERNATIVES

9.1 MUNICIPAL SERVICING OF PRIVATE CONNECTIONS

The results of the evaluation indicate that it would be beneficial to transfer all existing privately serviced sites to municipal servicing. Three (3) categories have been assigned priorities which correlates to the recommended timing of servicing within these three categories. An individual parcel review has been completed; however, certain parcel groups have been evaluated separately, and have been assigned staging independent of the overarching property category. A staging and development plan is provided below in Table 9-1.

Table 9-1: Staging and Development Plan for Providing Municipal Servicing to Properties currently with Private Servicing

Priority	Category	Year of Implementation
1	Category 3: Industrial/Commercial Properties	2019
2	Category 1: Properties within Wellhead Protection Areas • Property Group 7 is in an ESA, therefore municipal servicing is not recommended • Property Groups 8, 9, & 30 are recommended to be serviced with the North Beaver Creek development area, and municipal servicing is to be provided at once this infrastructure is installed.	2024 Not Recommended 2029 (Dependent on timing of Beaver Creek Infrastructure)
3	Category 2: Properties outside Wellhead Protection Areas • Property Group 6 exceeds the capacity of Millennium SPS, therefore extensive infrastructure upgrades would be required before servicing.	2029 Beyond 2029

9.2 IMPROVING MAPLE HILL TRUNK CAPACITY

The top ranked alternative is 4D, which consists of reconfiguring the overflow structure along Thorndale Drive to divert flow along Westvale Drive/Fischer-Hallman Road to the lower Maple Hill Trunk. This alternative allows residual capacity within the system to be utilized, the cost to reconfigure one manhole is expected to be less than the cost of twinning or replacing the length of pipe. In addition, this alternative does not require work within the narrow easement and therefore improves accessibility during construction.

9.3 IMPROVING DOWNSTREAM FROBISHER SPS CAPACITY

The top ranked alternative for the constraint downstream of Frobisher SPS is alternative 5C, which consists of upgrading the pipe size along Frobisher Drive. This alternative is recommended because it reduces operations and maintenance due to the removal of old infrastructure, and reduced risk of utility conflicts due to unchanged alignment.

9.4 IMPROVING LOWER FORWELL TRUNK CAPACITY

The recommended preferred solution is 6A which is the 'do nothing' alternative. This capacity constraint has a low risk of causing basement flooding, and falls within an environmentally sensitive area. However this is a major trunk, and is expected to receive flows from the St. Jacobs WWTP. Flow monitoring is recommended at the time that the St. Jacobs WWTP flows are directed to the Forwell Trunk to ensure that capacity is maintained.

This capacity constraint only emerges once the properties on septic systems are connected, specifically Category 1. In the event that the City choses Alternative 6B or 6C, twinning or upsizing this section of pipe, recommended staging would follow the connection of properties currently on septic systems (Category 1).

9.5 I/I MONITORING PROGRAM

The following areas are recommended for future flow monitoring and additional locations will be outlined in the Tech Memo 5. These areas represent opportunity to understand longer term I/I impacts in addition to new point loads entering the sanitary system:

1. Downtown Core as part of the Optimization and Rehabilitation Program.
2. Clair Trunk.
3. Cedar Trunk.
4. Forwell Trunk.

9.6 OPTIMIZATION AND REHABILITATION PROGRAM

Optimization and rehabilitation is recommended based on study of three priority areas:

1. Priority Area 1 –Core Area overlapping with Station Areas with older infrastructure.
2. Priority Area 2 – Station Areas with older infrastructure.
3. Priority Area 3 – All other areas with older infrastructure.

Within each of the areas, a study phase followed by rehabilitation stage is recommended:

1. Study of Catchment:
    a. Data Validation.
    b. Model Checks.
    c. CCTV (review existing and new, as needed).
    d. Flow monitoring.
    e. Development of rehabilitation strategy/tender.
2. Rehabilitation of Catchment.
3. Repeat for catchments within Priority Area and then move on to next priority area.

10.0 IMPLEMENTATION AND STAGING

Recommended sewer infrastructure works are categorized into Priority Projects and Strategic Projects. The Priority Projects are recommended to be completed within the next five year cycle, and Strategic Projects are grouped into five year increments. Implementation and staging of the preliminary preferred alternatives are proposed in the following timeframes:

- Planning Period 1: Present to 2019 (Priority Projects)
- Planning Period 2: 2020 to 2024 (Strategic Projects)
- Planning Period 3: 2025 to 2029 (Strategic Projects)

Staging and implementation for the municipal service connection for existing properties on private services has been developed based on the established priority groups. The highest priority group is scheduled for implementation prior to the lower priority groups.

The staging of capacity constraint solutions is based on the planning period in which the constraint was identified during the modelling process. The staging has been adjusted to allow funds to be distributed throughout the planning periods.

The I/I Monitoring Program is recommended to operate continually throughout the planning periods. However, the purchase of additional flow monitors is anticipated during the first year of implementation, therefore an increased cost will be anticipated in the 2016 to 2019 planning period.

Table 10-1 shows the preliminary recommended projects and proposed Planning Periods.

Table 10-1: Preliminary Plan for Implementation and Staging

Preliminary Preferred Alternative/Recommendation	Present to 2019	2020 to 2024	2025 to 2029
Municipal Servicing – Priority 1	✓ $132,000		
Municipal Servicing – Priority 2		✓ $2,805,000	
Municipal Servicing – Priority 3			✓ $9,644,000
Maple Hill Trunk Capacity	✓ $36,000		
Frobisher SPS Downstream – Trunk Capacity		✓ $164,000	
Lower Forwell Trunk Capacity			✓ Do Nothing
I/I Program	✓ $194,000	✓ $160,000	✓ $160,000
Optimization and Rehabilitation – Priority 1	✓ $1,641,000	✓ $547,000	
Optimization and Rehabilitation – Priority 2		✓ $467,000	✓ $467,000
Optimization and Rehabilitation – Priority 3		✓ $678,000	✓ $1,376,000
Total Costs per Planning Period	**$2,003,000**	**$4,821,000**	**$11,647,000**

APPENDIX A: MUNICIPAL SERVICING FOR EXISTING PRIVATE SERVICES

Stantec

Memo

To:	Jakub Cyperling, CET City of Waterloo	From:	Leigh McDermott, M.E.Sc., P.Eng. Stantec Consulting Ltd.
File:	1611 11191/10	Date:	February 13, 2015

Reference: Flow Allocations Assumptions for Existing Properties on Septic Systems

1.0 MUNICIPAL SERVICING FOR EXISTING PRIVATE SERVICES

The City has identified properties which are currently services by private services. A map of these properties is shown in Figure 1 (attached). A total of 359 properties are identified. Of these properties, 244 have associated water records (excluding those with zero water consumption). These properties had populations and flows during the model development phase of the project based on the City population and water consumption rates for each property. Population allocation is discussed in further detail in TM6. The remaining 115 properties have been assigned flows based on property type and design flow rates from the following sources:

- DGSSMS (Region of Waterloo, 2015)
- Design Guidelines for Sewage Works (MOE, 2008)
- District Plans (City of Waterloo, 2013)

1.1 RESIDENTIAL PROPERTIES

Persons per unit (PPU) rates outlined in the District Plans (provided via email correspondence with the City on April 29, 2014) were used to assign population to residential properties. The PPU rates outlined in the District Plans were as follows:

- Single and semi-detached dwellings - 3.3 PPU
- Townhome dwellings - 2.48 PPU
- Apartments - 1.83 PPU

Dry weather average sewage flows were calculated using a design per capita rate of 350 L/c/d, as per the Design Guidelines and Supplemental Specifications for Municipal Services (DGSSMS).

1.2 INSTITUTIONAL, COMMERCIAL, AND INDUSTRIAL (ICI) PROPERTIES

Based on the property code, seven (7) properties have been identified as ICI properties. Design flow rates of 0.5 L/s/ha for industrial and 0.6 L/s/ha for commercial properties have been used, as per the DGSSMS. The parcels classified as property code 701 '*Places of Worship*' were allocated conservative flows of 70 L/d/person (0.00081 L/s/person), which is the recommended flow rate for a small school as per Table 5-3 of the Design Guidelines for Sewage Works 2008 (Ministry of the Environment, 2008). All flow allocation assumptions are shown in Table 1 below.

Reference: Flow Allocations Assumptions for Existing Properties on Septic Systems

Table 1: Flow Allocation Summary for Privately Serviced Properties

Property Code	Description	Count	Residential People Per Property	ICI Property Flow Assumptions
332	Duplex	1	Apartments - 1.83 PPU (2 units) Total Pop - 3.66	
490	Golf course	1		0.6 L/s/ha Commercial Property
230	Intensive farm operation - without residence	1		0.5 L/s/ha Industrial Property
261	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	1	Single and semi-detached dwellings - 3.3 PPU	
302	More than one structure used for residential purposes with a least one of the structures occupied permanently	2	Single and semi-detached dwellings - 3.3 PPU	
701	Place of worship - without a clergy residence	3		70 L/d/person (0.00081 L/s/person) Assume 50 people
303	Residence with a commercial unit	2	Single and semi-detached dwellings - 3.3 PPU	
304	Residence with a commercial/industrial use building	1		0.5 L/s/ha Industrial Property
333	Residential property with three self-contained units	1	Apartments - 1.83 PPU (3 units) Total Pop - 5.49	
301	Single-family detached not on water)	97	Single and semi-detached dwellings - 3.3 PPU	
105	Vacant commercial land	1		0.6 L/s/ha Commercial Property
100	Vacant residential land not on water	4	Single and semi-detached dwellings - 3.3 PPU	
	Grand Total	**115**		

Reference: Flow Allocations Assumptions for Existing Properties on Septic Systems

Should you have any questions or wish to discuss, please contact our office.

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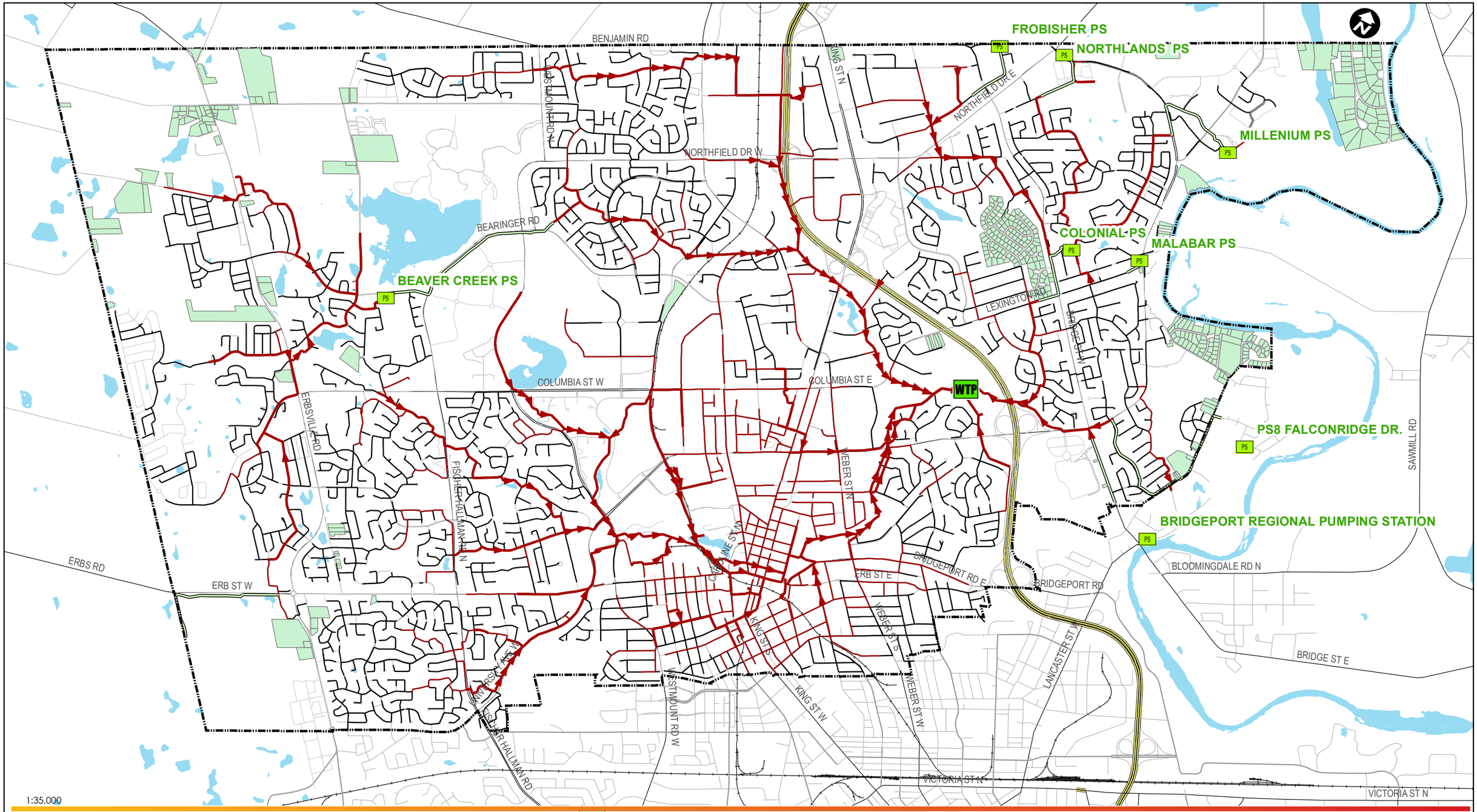
Attachment



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Legend

- CityBoundary
- Water Body
- Forcemain
- PS Existing Pump Station
- WTP Wastewater Treatment Plant

All Sanitary Sewers
- Local Sewers
- Trunk Sewers

Model Selection Set
- Local Sewers
- Trunk Sewers

Properties on Septic

1611-11191

Figure No. FIGURE 1

Title **CURRENT PROPERTIES SERVICED BY SEPTIC SYSTEMS**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE

APPENDIX B: EVALUATION OF ALTERNATIVES

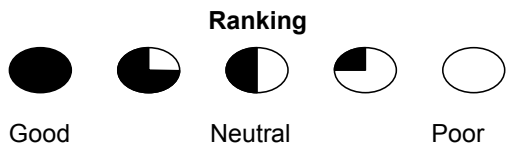
Table B1: Detailed Evaluation of Alternatives for Private Servicing Categories

Ranking

Ranking			Servicing Alternative					
			1. Within Wellhead Protection Areas		2. Outside Wellhead Protection Areas		3. Industrial/Commercial Properties	
			1A	1B	2A	2B	3A	3B
Category	**Criteria**	**Weight**	Do Nothing	Municipal Servicing	Do Nothing	Municipal Servicing	Do Nothing	Municipal Servicing
Technical	Hydraulic Improvements	1						
	Operations and Maintenance	1						
	System Resiliency	1						
Ease of Implementation	Constructability	1						
	Regulatory Considerations	1	-	-	-	-	-	-
Social	Impact for Surrounding Residents	1						
System Suitability	Consistency with Planned Upgrades	1						
	Consistency with Operating Strategies	1						
Environment/ Sustainability	Carbon Footprint	1						
	Impact on Terrestrial/ Aquatic Systems	1						
Financial	Capital Cost	1						
	Operating and Maintenance Cost	1						
Total Score			5 1/2	6	5 1/2	5 3/4	5 1/2	6 1/4

Comments		Servicing Alternative					
		1. Within Wellhead Protection Areas		2. Outside Wellhead Protection Areas		3. Industrial/Commercial Properties	
		1A	1B	2A	2B	3A	3B
Category	**Criteria**	Do Nothing	Municipal Servicing	Do Nothing	Municipal Servicing	Do Nothing	Municipal Servicing
Technical	Hydraulic Improvements	Poor	Improvement	Poor	Improvement	Poor	Improvement
	Operations and Maintenance	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
	System Resiliency	Poor - limited resiliency	Increased resiliency	Poor - limited resiliency	Increased resiliency	Poor - limited resiliency	Increased resiliency
Ease of Implementation	Constructability	Neutral - no change	Neutral - site specific	Neutral - no change	Neutral - site specific	Neutral - no change	Neutral - site specific
	Regulatory Considerations	N/A	N/A	N/A	N/A	N/A	N/A
Social	Impact for Surrounding Residents	Good - no impact to residents, however, do not receive improved municipal service	Upfront cost and construction can be expected to result in resistance from impacted residents	Good - no impact to residents, however, do not receive improved municipal service	Upfront cost and construction can be expected to result in resistance from impacted residents	Good - no impact to residents, however, do not receive improved municipal service	Upfront cost and construction can be expected to result in resistance from impacted residents
System Suitability	Consistency with Planned Upgrades	Neutral - site specific	Neutral - site specific	Neutral - site specific	Neutral - site specific	Neutral - site specific	Neutral - site specific
	Consistency with Operating Strategies	Neutral - site specific	Neutral - site specific	Neutral - site specific	Neutral - site specific	Neutral - site specific	Neutral - site specific
Environment/ Sustainability	Carbon Footprint	Poor - regular septage pumping/trucking results in GHG emissions	Neutral - site specific. Reduced septage pumping/ trucking reduces GHG emissions if gravity sewer connection is possible. Addition of SPS may increase or be the same as existing GHG emissions	Poor - regular septage pumping/trucking results in GHG emissions	Neutral - site specific. Reduced septage pumping/ trucking reduces GHG emissions if gravity sewer connection is possible. Addition of SPS may increase or be the same as existing GHG emissions	Poor - regular septage pumping/trucking results in GHG emissions	Good - site is located in close proximity to supporting natural feature.
	Impact on Terrestrial/ Aquatic Systems	Poor - current state represents an increased risk for sewage spills and leaks to the environment	Reduced impact - reduces chances for septage spill/ overflow in environmentally protected area. Spills could impact water supply	Poor - current state represents an increased risk for sewage spills and leaks to the environment	Reduced impact - reduces chances for septage spill/ overflow in the environment.	Poor - current state represents an increased risk for sewage spills and leaks to the environment	Reduced impact - reduces chances for septage spill/ overflow into the environment
Financial	Capital Cost	Good - no current costs to the City, responsibility of property owners	Poor - high initial capital investment of new infrastructure and large number of sites in this category. Cost sharing with properties possible	Good - no current costs to the City, responsibility of property owners	Poor - high initial capital investment of new infrastructure and large number of sites in this category. Cost sharing with properties possible	Good - no current costs to the City, responsibility of property owners	good - site is located in close proximity municipal servicing. Cost sharing with properties possible
	Operating and Maintenance Cost	Good - no current costs to the City, responsibility of property owners	Poor - additional infrastructure will have costs over lifetime, whether pipes or SPS at large number of sites in this category	Good - no current costs to the City, responsibility of property owners	Poor - additional infrastructure will have costs over lifetime, whether pipes or SPS at large number of sites	Good - no current costs to the City, responsibility of property owners	neutral - additional infrastructure will have costs over lifetime, whether pipes or SPS, but limited infrastructure required

Table B2: Detailed Evaluation of Maple Hill Trunk Alternatives



Ranking		Alternative			
		Maple Hill Trunk Capacity			
		4A	4B	4C	4D
Category	**Criteria**	Do Nothing	Twin Sewer Section	Replace Sewer Section	Divert Flow
Technical	Hydraulic Improvements				
	Operations and Maintenance				
	System Resiliency				
Ease of Implementation	Constructability				
	Regulatory Considerations				
Social	Impact for Surrounding Residents				
System Suitability	Consistency with Planned Upgrades				
	Consistency with Operating Strategies				
Environment/ Sustainability	Carbon Footprint				
	Impact on Terrestrial/ Aquatic Systems				
Financial	Capital Cost				
	Operating and Maintenance Cost				
Total Score		6	6 3/4	7 1/4	8 1/4

Comment		Alternative			
		Maple Hill Trunk Capacity			
		4A	4B	4C	4D
Category	**Criteria**	Do Nothing		Replace Sewer Section	Divert Flow
Technical	Hydraulic Improvements	poor - continued capacity constraint	good - address hydraulic constraint	good - address hydraulic constraint	good - address hydraulic constraint temporarily
	Operations and Maintenance	poor - risk of surcharging, additional maintenance	neutral - no change	neutral - no change	neutral - no change
	System Resiliency	poor - capacity constraint identified under wet weather	good - improved resiliency under wet weather conditions	good - improved resiliency under wet weather conditions	good - improved resiliency under wet weather conditions
Ease of Implementation	Constructability	good - no construction required	poorer - easement width may not permit construction	poor - requires bypass pumping	good - reconfigure one manhole, required bypass pumping
	Regulatory Considerations	neutral - no change	poor - easement boundaries may be limitation	neutral - no change	neutral - no change
Social	Impact for Surrounding Residents	neutral - no change; no nearby residents	neutral - no change	neutral - no change	neutral - no change
System Suitability	Consistency with Planned Upgrades	poor - capacity constraint identified	good - addresses capacity constraint	good - addresses capacity constraint	good - addresses capacity constraint
	Consistency with Operating Strategies	poor - capacity constraint identified	good - no changes to operations	good - no changes to operations	neutral - alters existing operating strategy, but not negative
Environment/ Sustainability	Carbon Footprint	good - use of existing infrastructure	poor - additional pipe section	poor - replace pipe section	good - use of existing infrastructure
	Impact on Terrestrial/ Aquatic Systems	poor - increased risk of spills to environment	good - reduces risk of spills to the environment; same footprint	good - reduces risk of spills to the environment; same footprint	good - no construction through easement, near creek
Financial	Capital Cost	good - no capital cost	poor - capital cost of twinned section, no bypass pumping	poor - capital cost of replacement and bypass pumping	good - capital cost includes manhole reconfiguration and bypass pump
	Operating and Maintenance Cost	neutral - no change	neutral - no change	neutral - no change	neutral - no significant change

Table B3: Detailed Evaluation of Downstream Frobisher SPS Alternatives

Ranking

Ranking		Alternative		
		Downstream of Frobisher SPS		
		5A	5B	5C
Category	**Criteria**	Do Nothing	Twin Sewer	Replace Sewer Section
Technical	Hydraulic Improvements			
	Operations and Maintenance			
	System Resiliency			
Ease of Implementation	Constructability			
	Regulatory Considerations	-	-	-
Social	Impact for Surrounding Residents			
System Suitability	Consistency with Planned Upgrades			
	Consistency with Operating Strategies			
Environment/ Sustainability	Carbon Footprint			
	Impact on Terrestrial/ Aquatic Systems			
Financial	Capital Cost			
	Operating and Maintenance Cost			
Total Score		5	5 3/4	6 3/4

*when would you want to twin vs just replace section of pipe?

Comment		Alternative		
		Downstream of Frobisher SPS		
		5A	5B	5C
Category	**Criteria**	Do Nothing	Twin Sewer	Replace Sewer Section
Technical	Hydraulic Improvements	poor - continued capacity constraint	good - address hydraulic constraint	good - address hydraulic constraint
	Operations and Maintenance	poor - risk of surcharging	neutral - no change	good - removed old pipe from system
	System Resiliency	poor - capacity constraint identified under wet weather	good - address hydraulic constraint	good - address hydraulic constraint
Ease of Implementation	Constructability	good - no construction required	neutral - no change	neutral - less disruptive, less risk of utility conflicts
	Regulatory Considerations	N/A	N/A	N/A
Social	Impact for Surrounding Residents	poor - may result in increase basement flooding	poorer - disruption to traffic	poorer - disruption to traffic
System Suitability	Consistency with Planned Upgrades	poor - capacity constraint identified	good - addresses capacity constraint	good - addresses capacity constraint
	Consistency with Operating Strategies	poor - capacity constraint identified	good - no changes to operations	good - no changes to operations
Environment/ Sustainability	Carbon Footprint	good - use of existing infrastructure	poorer - adding additional pipe	poorer - replace pipe section
	Impact on Terrestrial/ Aquatic Systems	poor - increased risk of spills to environment	good - reduces risk of spills to the environment; same footprint	good - reduces risk of spills to the environment; same footprint
Financial	Capital Cost	good - no capital cost	poor - capital cost of twinned sewer	poor - capital cost of replacement
	Operating and Maintenance Cost	neutral - no change	poor - additional pipe to maintain	neutral - no change

Table B4: Detailed Evaluation of Lower Forwell Alternatives

Ranking

Ranking		Alternative		
		Lower Forwell Trunk		
		6A	6B	6C
Category	**Criteria**	Do Nothing	Twin Sewer	Replace Sewer Section
Technical	Hydraulic Improvements	○	◔	●
	Operations and Maintenance	◔	◖	◔
	System Resiliency	○	●	●
Ease of Implementation	Constructability	●	◔	◔
	Regulatory Considerations	●	◔	◔
Social	Impact for Surrounding Residents	◔	◖	◖
System Suitability	Consistency with Planned Upgrades	○	◔	◔
	Consistency with Operating Strategies	◖	◖	◖
Environment/ Sustainability	Carbon Footprint	◔	◔	◔
	Impact on Terrestrial/ Aquatic Systems	●	◖	◖
Financial	Capital Cost	●	◔	◔
	Operating and Maintenance Cost	●	◔	◖
Total Score		7 1/4	5 1/4	6

Comment		Alternative		
		Downstream of Beaver Creek SPS		
		6A	6B	6C
Category	**Criteria**	Do Nothing	Twin Sewer	Replace Sewer Section
Technical	Hydraulic Improvements	poor - continued capacity constraint; necessary for growth	good - address hydraulic constraint	good - Opportunity to increase slope
	Operations and Maintenance	poor - risk of surcharge	neutral - no change	good - removed old pipe from system
	System Resiliency	poor - capacity constraint identified under wet weather	good - address hydraulic constraint	good - address hydraulic constraint
Ease of Implementation	Constructability	good - no construction required	neutral - no change	neutral - less disruptive, less risk of utility conflicts
	Regulatory Considerations	Neutral	poor - environmentally sensitive area	poor - environmentally sensitive area
Social	Impact for Surrounding Residents	good - low risk of basement flooding	poorer - may impact use of trails	poorer - may impact use of trails
System Suitability	Consistency with Planned Upgrades	poor - capacity constraint identified	good - addresses capacity constraint	good - addresses capacity constraint
	Consistency with Operating Strategies	poor - capacity constraint identified	good - no changes to operations	good - no changes to operations
Environment/ Sustainability	Carbon Footprint	neutral - use of existing infrastructure	poorer - adding additional pipe	poorer - replace pipe section
	Impact on Terrestrial/ Aquatic Systems	good - low risk of spills to environment, no construction required	poor - environmentally sensitive area	poor - environmentally sensitive area
Financial	Capital Cost	good - no capital cost	poor - capital cost of twinned sewer	poor - capital cost of replacement
	Operating and Maintenance Cost	neutral - no change	poor - additional pipe to maintain	neutral - no change

APPENDIX C: UNIT COSTS

Appendix C: Unit Costs - Capital

Item	Unit	Unit Cost
200mm-PVC Sewer (3-5 m deep)	m	$471.41
250mm-PVC Sewer (3-5 m deep)	m	$526.10
300mm-C100 Concrete Sewer (3-5 m deep)	m	$575.71
300mm-PVC Sewer (3-5 m deep)	m	$583.47
375mm-C100 Concrete Sewer (3-5 m deep)	m	$624.90
375mm-PVC Sewer (3-5 m deep)	m	$654.36
450mm-PVC Sewer (3-5 m deep)	m	$791.87
450mm-C100 Concrete Sewer (3-5 m deep)	m	$644.29
525mm-C100 Concrete Sewer (3-5 m deep)	m	$705.74
525mm-PVC Sewer (3-5 m deep)	m	$938.58
600mm-C100 Concrete Sewer (3-5 m deep)	m	$788.59
600mm-PVC Sewer (3-5m deep)	m	$1,055.82
675mm-C100 Concrete Sewer (3-5 m deep)	m	$1,056.38
750mm-C100 Concrete Sewer (3-5 m deep)	m	$1,200.50
750mm-C140 Concrete Sewer (5-9 m deep)	m	$1,940.10
825mm-C100 Concrete Sewer (3-5 m deep)	m	$1,361.20
825mm-C140 Concrete Sewer (5-9 m deep)	m	$2,107.18
900mm-C100 Concrete Sewer (3-5 m deep)	m	$1,501.88
900mm-C140 Concrete Sewer (5-9 m deep)	m	$2,251.59
965mm-x-1525mm Concrete Elliptical (3-5 m deep)	m	$1,941.27
975mm-C100 Concrete Sewer (3-5 m deep)	m	$1,636.89
975mm-C140 Concrete Sewer (5-9 m deep)	m	$2,400.22
1050mm-C100 Concrete Sewer (3-5 m deep)	m	$1,825.03
1050mm-C140 Concrete Sewer (5-9 m deep)	m	$2,586.86
1200mm-C100 Concrete Sewer (3-5 m deep)	m	$2,110.96
1200mm-C140 Concrete Sewer (5-9 m deep)	m	$2,889.25
1350mm-C100 Concrete Sewer (3-5 m deep)	m	$2,434.61
1350mm-C140 Concrete Sewer (5-9 m deep)	m	$3,236.52
1500mm-C100 Concrete Sewer (3-5 m deep)	m	$2,928.31
1500mm-C140 Concrete Sewer (5-9 m deep)	m	$3,859.14
1650mm-C100 Concrete Sewer (3-5 m deep)	m	$3,342.42
1650mm-C100 Concrete Sewer (5-9 m deep)	m	$4,296.76
1800mm-C100 Concrete Sewer (3-5 m deep)	m	$3,853.49
1800mm-C140 Concrete Sewer (5-9 m deep)	m	$4,831.46
1950mm-C100 Concrete Sewer (3-5 m deep)	m	$4,329.79
1950mm-C140 Concrete Sewer (5-9 m deep)	m	$5,331.28
2100mm-C100 Concrete Sewer (3-5 m deep)	m	$4,837.61
2100mm-C140 Concrete Sewer (5-9 m deep)	m	$5,862.50
2250mm-C100 Concrete Sewer (3-5 m deep)	m	$5,381.11
2250mm-C140 Concrete Sewer (5-9 m deep)	m	$6,424.50
2400mm-C100 Concrete Sewer (3-5 m deep)	m	$6,122.95
2400mm-C140 Concrete Sewer (5-9 m deep)	m	$7,189.86
2700mm-C100 Concrete Sewer (3-5 m deep)	m	$6,776.70
2700mm-C140 Concrete Sewer (5-9 m deep)	m	$7,867.00
3000mm-C100 Concrete Sewer (3-5 m deep)	m	$8,873.44
3000mm-C140 Concrete Sewer (5-9 m deep)	m	$10,041.13
Excavation, Hauling & Disposal	t	$100.00
Road Regrading	m²	$150.00
Road Restoration - Arterial	m	$266.52
Road Restoration - Collector	m	$208.72
Road Restoration - Local	m	$174.04
Rock Excavation (Linear Works)	m3	$100.00
Sodding	m²	$10.00

Appendix C: Unit Costs - Capital

Item	Unit	Unit Cost
Trenchless - 450mm	m	$2,000.00
Trenchless - 900mm	m	$5,600.00
Micro-Tunnel - 1800mm	m	$6,500.00
1800mm ID Short Clay Soil Tunnel	m	$10,000.00
3000mm ID Short Clay Soil Tunnel	m	$12,000.00
3000mm ID Short Rock Tunnel	m	$8,000.00
Tunnel Entry/Exit Shaft/Mobilization	ea	$2,500,000.00
Underground Tank - Gravity (<=10000m3)	m3	$1,500.00
Underground Tank - Gravity (>10000m3)	m3	$1,100.00
Underground Tank - Pumping (<=10000m3)	m3	$1,750.00
Underground Tank - Pumping (>10000m3)	m3	$1,500.00
Connection of existing pipe to new MH	ea	$2,974.11
Remove and dispose existing and replace with new 1200 mm dia pre-cast MH Depth to 4 m.	ea	$8,829.75
Remove and dispose existing and replace with new 1200 mm dia pre-cast MH Depth to 6 m.	ea	$13,610.07
Remove and dispose existing and replace with new 1200 mm dia pre-cast MH Depth to 9 m.	ea	$50,045.28
Remove and dispose existing and replace with new 1200 mm dia pre-cast MH Depth to 11 m.	ea	$69,058.51
Bypass Pumping of Sewage (1 week)	per week	$4,700.00
Grinder Pump (eOne System)	ea	$10,000.00
Low Pressure System - Forcemain	m	$100.00
Up to 50 L/s	per L	$30,000.00
Up to 200 L/s	per L	$20,000.00
Installation of Lateral	ea	$4,000.00

Notes:

Sewers Include:

- conventional trench box
- granular backfill
- traffic control
- standard Manholes and appurtenances
- standard dewatering
- road restoration incl. sod, asphalt, curb

Tunnel Factors:

- limited geotechnical information is available
- number/location/complexity of the shafts is unknown

rock or soft ground quality, water issues, contamination, or crossing faults.

Appendix C: Unit Costs - Rehabilitation

Rehabilitation Method	Cost	Unit
CCTV Mainline Investigation + Flushing	$5.00	m
Relining Options		
Cured-in-Place Pipe	$225.00	m
Sliplining	$1,300.00	m
Chemical Grouting	$1,500.00	per spot repair
Replacement Options		
Pipe Bursting	$7,000.00	per line
Manhole Rehabilitation		
Manhole Resealing (sealant)	$2,000.00	per manhole
Manhole Resealing (sleeve)	$3,000.00	per manhole
Frame and Cover System	$3,300.00	per manhole

APPENDIX D: COSTING OF ALTERNATIVES

City of Waterloo Sanitary Servicing Master Plan Update
Project Cost Allowance

Items			Alternative 1A Construction Cost	Alternative 1B Construction Cost	Alternative 2A Construction Cost	Alternative 2B Construction Cost	Alternative 3A Construction Cost	Alternative 3B Construction Cost
Capital Cost	LS (<=$1.5M)	LS (>$1.5M)	-	$ 84,000.00	-	$ 1,818,732.05	-	$ 6,253,828.82
Capital Cost Contingency	20%	20%	-	$ 16,800.00	-	$ 363,746.41	-	$ 1,250,765.76
Capital + Contingency			-	$ 100,800.00	-	$ 2,182,478.46	-	$ 7,504,594.58
Project Delivery Allowance								
Engineering Services	16%	16%						
Preliminary Design	3%	3%	-	$ 2,520.00	-	$ 54,561.96	-	$ 187,614.86
Design & Tendering	5%	5%	-	$ 5,040.00	-	$ 109,123.92	-	$ 375,229.73
Construction Services	8%	8%	-	$ 8,064.00	-	$ 174,598.28	-	$ 600,367.57
Project Management and Admin (City)	5%	3%	-	$ 5,040.00	-	$ 65,474.35	-	$ 225,137.84
Project Delivery Contingency	10%	10%	-	$ 10,080.00	-	$ 218,247.85	-	$ 750,459.46
Total Project Delivery Allowance			-	$ 30,744.00	-	$ 622,006.36	-	$ 2,138,809.45
Total Project Cost Estimate			**-**	**$ 131,544.00**	**-**	**$ 2,804,484.82**	**-**	**$ 9,643,404.03**

Capital Cost
Defined as the estimated construction cost of the proposed works

Capital Cost Contingency
Defined as an allowance as a percentage of capital cost that recognizes conceptual nature of the project definition and the

Engineering Services
Defined as an allowance as a percent of capital construction costs plus contingency for detailed design, construction services, commissioning, calibration and programming, utility relocates.

Project Management and Admin (City)
Defined as an allowance for internal management and administration as a percentage of capital construction costs plus contingency, and Engineering Services. 3% for Projects >$1.5M; 5% for Projects <=$1.5M.

Project Delivery Contingency
Defined as an allowance as a percentage of all other project delivery costs.

City of Waterloo Sanitary Servicing Master Plan Update
Opinion of Probable Cost Details - Capital Cost

Alternatives 1 to 3: Existing Properties on Private Services

Asset ID	Type	Description	Remedial Measure Category	Pipe Diameter (mm)	Element	Unit	Unit Quantity	Unit Cost ($/unit)	Capital Cost
Alt 1A: Do Nothing									
No Cost									$0
Alt 1A: Subtotal									**$0**
Alt 1B: Connect to Network									
N/A	Laterals	Category 1			Installation of Lateral	ea.	21.0	$4,000	$84,000
Alt 1B: Subtotal									**$84,000**
Alt 2A: Do Nothing									
No Cost									$0
Alt 2A: Subtotal									**$0**
Alt 2B: Connect to Network									
N/A	Pipe	Category 2	Gravity Main	375	375mm-C100 Concrete Sewer (3-5 m deep)	m	1,395.0	$625	$871,732
N/A	Laterals	Category 2	Lateral Installation		Installation of Lateral	ea	233.0	$4,000	$932,000
N/A	Grinder Pump Installation	Category 2	Grinder Pump Installation		Grinder Pump (eOne System)	ea	1.0	$10,000	$10,000
N/A	Small Diameter Forcemain Installation	Category 2	Small Diameter Forcemain Installation		Low Pressure System - Forcemain	m	50.0	$100	$5,000
Alt 2B: Subtotal									**$1,818,732**
Alt 2A: Do Nothing									
No Cost									$0
Alt 2A: Subtotal									**$0**
Alt 3B: Connect to Network									
N/A	Pipe	Category 3	Gravity Main	375	300mm-C100 Concrete Sewer (3-5 m deep)	m	5,915.0	$576	$3,405,329
N/A	Laterals	Category 3	Lateral Installation	450	Installation of Lateral	ea	219.0	$4,000	$876,000
N/A	Grinder Pump Installation	Category 3	Grinder Pump Installation		Grinder Pump (eOne System)	ea	141.0	$10,000	$1,410,000
N/A	Small Diameter Forcemain Installation	Category 3	Small Diameter Forcemain Installation		Low Pressure System - Forcemain	m	5,625.0	$100	$562,500
Alt 3B: Subtotal									**$6,253,829**

City of Waterloo Sanitary Servicing Master Plan Update
Project Cost Allowance

Items	Approach		Alternative 4A Construction Cost	Alternative 4B Construction Cost	Alternative 4C Construction Cost	Alternative 4D Construction Cost
Capital Cost	LS		$0	141,725	178,988	22,452
Capital Cost Contingency	20%		-	28,345	35,798	4,490
Capital + Contingency			-	170,070	214,785	26,943
Project Delivery Allowance						
Engineering Services	16%					
Preliminary Design	3%	of Capital + Contingency	-	4,252	5,370	674
Design & Tendering	5%	of Capital + Contingency	-	8,504	10,739	1,347
Construction Services	8%	of Capital + Contingency	-	13,606	17,183	2,155
Project Management and Admin (City)	5%	*of above (Capital + Contingency & Eng. Serv.)	-	8,504	10,739	1,347
Project Delivery Contingency	10%	of above (Eng Serv. & City PM)	-	17,007	21,478.55	2,694
Total Project Delivery Allowance			-	51,871	65,510	8,217
Total Project Cost Estimate			**-**	**221,942**	**280,295**	**35,160**

Capital Cost
Defined as the estimated construction cost of the proposed works

Capital Cost Contingency
Defined as an allowance as a percentage of capital cost that recognizes conceptual nature of the project definition and the limited

Engineering Services
Defined as an allowance as a percent of capital construction costs plus contingency for detailed design, construction services, commissioning, calibration and programming, utility relocates.

Project Management and Admin (City)
Defined as an allowance for internal management and administration as a percentage of capital construction costs plus contingency, and Engineering Services. 3% for Projects >$1.5M; 5% for Projects <=$1.5M.

Project Delivery Contingency
Defined as an allowance as a percentage of all other project delivery costs.

City of Waterloo Sanitary Servicing Master Plan Update
Opinion of Probable Cost Details - Capital Cost

Alternative 4: Maple Hill Trunk

Asset ID	Type	Street	Remedial Measure Category	Pipe Diameter (mm)	Element	Unit	Unit Quantity	Unit Cost ($/unit)	Capital Cost
Alt 4A: Do Nothing									
No Cost									$0
Alt 4A: Subtotal									**$0**
Alt 4B: Twin Sewer									
9244	Pipe	Easement (Thorndale Drive)	Sanitary Parallel Pipe	200	200mm-PVC Sewer (3-5 m deep)	m	84.7	$471	$39,929
9249	Pipe	Easement (Thorndale Drive)	Sanitary Parallel Pipe	250	250mm-PVC Sewer (3-5 m deep)	m	98.8	$526	$51,979
New Pipe	Pipe	Easement (Thorndale Drive)	Connecting Pipe	200	200mm-PVC Sewer (3-5 m deep)	m	2.0	$471	$943
New Pipe	Pipe	Easement (Thorndale Drive)	Connecting Pipe	250	250mm-PVC Sewer (3-5 m deep)	m	2.0	$526	$1,052
N/A	Bypass Pumping	Easement (Thorndale Drive)	Bypass Pumping	N/A	Bypass Pumping of Sewage (1 week)	per wk	10.2	$4,700	$47,823
Alt 4B: Subtotal									**$141,725**
Alt 4C: Upgrade Sewer									
9244	Pipe	Easement (Thorndale Drive)	Sanitary Upgrade	375	375mm-C100 Concrete Sewer (3-5 m deep)	m	84.7	$625	$52,929
9249	Pipe	Easement (Thorndale Drive)	Sanitary Upgrade	450	450mm-PVC Sewer (3-5 m deep)	m	98.8	$792	$78,237
N/A	Bypass Pumping	Easement (Thorndale Drive)	Bypass Pumping	N/A	Bypass Pumping of Sewage (1 week)	per wk	10.2	$4,700	$47,823
Alt 4C: Subtotal									**$178,988**
Alt 4D: Divert Flows									
11895	MH	Westvale Dr and Thorndale Dr	Replace Manhole	300	Remove and dispose existing and replace with r	ea.	1.0	$8,830	$8,830
N/A	Pipe Connection	Westvale Dr and Thorndale Dr			Connection of existing pipe to new MH	ea.	3.0	$2,974	$8,922
N/A	Bypass Pumping	Westvale Dr and Thorndale Dr	Bypass Pumping	N/A	Bypass Pumping of Sewage (1 week)	per wk	1.0	$4,700	$4,700
Alt 4D: Subtotal									**$22,452**

City of Waterloo Sanitary Servicing Master Plan Update
Project Cost Allowance

Items	Approach		Alternative 5A Construction Cost	Alternative 5B Construction Cost	Alternative 5C Construction Cost
Capital Cost	LS		$0	79,456	104,252
Capital Cost Contingency	20%		-	15,891	20,850
Capital + Contingency			-	95,347	125,103
Project Delivery Allowance					
Engineering Services	16%				
Preliminary Design	3%	of Capital + Contingency	-	2,384	3,128
Design & Tendering	5%	of Capital + Contingency	-	4,767	6,255
Construction Services	8%	of Capital + Contingency	-	7,628	10,008
Project Management and Admin (City)	5%	*of above (Capital + Contingency & Eng. Serv.)	-	4,767	6,255
Project Delivery Contingency	10%	of above (Eng Serv. & City PM)	-	9,535	12,510
Total Project Delivery Allowance			-	29,081	38,156
Total Project Cost Estimate			**-**	**124,428**	**163,259**

Capital Cost

Defined as the estimated construction cost of the proposed works

Capital Cost Contingency

Defined as an allowance as a percentage of capital cost that recognizes conceptual nature of the project definition and the limited

Engineering Services

Defined as an allowance as a percent of capital construction costs plus contingency for detailed design, construction services, commissioning, calibration and programming, utility relocates.

Project Management and Admin (City)

Defined as an allowance for internal management and administration as a percentage of capital construction costs plus contingency, and Engineering Services. 3% for Projects >$1.5M; 5% for Projects <=$1.5M.

Project Delivery Contingency

Defined as an allowance as a percentage of all other project delivery costs.

City of Waterloo Sanitary Servicing Master Plan Update
Opinion of Probable Cost Details - Capital Cost

Alternative 5: Downstream of Frobisher SPS									
Asset ID	**Type**	**Street**	**Remedial Measure Category**	**Pipe Diameter (mm)**	**Element**	**Unit**	**Unit Quantity**	**Unit Cost ($/unit)**	**Capital Cost**
Alt 5A: Do Nothing									
No Cost									$0
Alt 5A: Subtotal									**$0**
Alt 5B: Twin Sewer									
8075	Pipe	Frobisher Drive	Sanitary Parallel Pipe	200	200mm-PVC Sewer (3-5 m deep)	m	30.0	$471	$14,142
8077	Pipe	Frobisher Drive	Sanitary Parallel Pipe	200	200mm-PVC Sewer (3-5 m deep)	m	17.7	$471	$8,344
14668	Pipe	Frobisher Drive	Sanitary Parallel Pipe	200	200mm-PVC Sewer (3-5 m deep)	m	83.1	$471	$39,174
New Pipe	Pipe	Frobisher Drive	Connecting Pipe	200	200mm-PVC Sewer (3-5 m deep)	m	2.0	$471	$943
New Pipe	Pipe	Frobisher Drive	Connecting Pipe	200	200mm-PVC Sewer (3-5 m deep)	m	2.0	$471	$943
N/A	Bypass Pumping	Frobisher Drive	Bypass Pumping	N/A	Bypass Pumping of Sewage (1 week)	per week	3.4	$4,700	$15,910
Alt 5B: Subtotal									**$79,456**
Alt 5C: Upgrade Sewer									
8075	Pipe	Frobisher Drive	Sanitary Upgrade	250	250mm-PVC Sewer (3-5 m deep)	m	30.0	$526	$15,783
8077	Pipe	Frobisher Drive	Sanitary Upgrade	250	250mm-PVC Sewer (3-5 m deep)	m	17.7	$526	$9,312
14668	Pipe	Frobisher Drive	Sanitary Upgrade	250	250mm-PVC Sewer (3-5 m deep)	m	83.1	$526	$43,719
N/A	Bypass Pumping	Frobisher Drive	Bypass Pumping	N/A	Bypass Pumping of Sewage (1 week)	per week	7.5	$4,700	$35,438
Alt 5C: Subtotal									**$104,252**

City of Waterloo Sanitary Servicing Master Plan Update
Project Cost Allowance

Items	Approach		Alternative 6A Construction Cost	Alternative 6B Construction Cost	Alternative 6C Construction Cost
Capital Cost	LS		$0	353,520	447,854
Capital Cost Contingency	20%		-	70,704	89,571
Capital + Contingency			-	424,224	537,425
Project Delivery Allowance					
Engineering Services	16%				
Preliminary Design	3%	of Capital + Contingency	-	10,606	13,436
Design & Tendering	5%	of Capital + Contingency	-	21,211	26,871
Construction Services	8%	of Capital + Contingency	-	33,938	42,994
Project Management and Admin (City)	5%	*of above (Capital + Contingency & Eng. Serv.)	-	21,211	26,871
Project Delivery Contingency	10%	of above (Eng Serv. & City PM)	-	42,422	53,742
Total Project Delivery Allowance			-	129,388	163,914
Total Project Cost Estimate			**-**	**553,613**	**701,339**

Capital Cost

Defined as the estimated construction cost of the proposed works

Capital Cost Contingency

Defined as an allowance as a percentage of capital cost that recognizes conceptual nature of the project definition and the limited

Engineering Services

Defined as an allowance as a percent of capital construction costs plus contingency for detailed design, construction services, commissioning, calibration and programming, utility relocates.

Project Management and Admin (City)

Defined as an allowance for internal management and administration as a percentage of capital construction costs plus contingency, and Engineering Services. 3% for Projects >$1.5M; 5% for Projects <=$1.5M.

Project Delivery Contingency

Defined as an allowance as a percentage of all other project delivery costs.

City of Waterloo Sanitary Servicing Master Plan Update
Opinion of Probable Cost Details

Alternative 6: Lower Forwell Trunk

Asset ID	Type	Street	Remedial Measure Category	Pipe Diameter (mm)	Element	Unit	Unit Quantity	Unit Cost ($/unit)	Capital Cost
Alt 6A: Do Nothing									
No Cost									$0
Alt 6A: Subtotal									**$0**
Alt 6B: Twin Sewer									
3906	Pipe	Hillside Park (Lexington Rd)	Sanitary Parallel Pipe	825	825mm-C100 Concrete Sewer (3-5 m deep)	m	107.4	$1,361	$146,207
3907	Pipe	Hillside Park (Lexington Rd)	Sanitary Parallel Pipe	825	825mm-C100 Concrete Sewer (3-5 m deep)	m	107.7	$1,361	$146,615
New Pipe	Pipe	Hillside Park (Lexington Rd)	Connecting Pipe	825	825mm-C100 Concrete Sewer (3-5 m deep)	m	2.0	$1,361	$2,722
New Pipe	Pipe	Hillside Park (Lexington Rd)	Connecting Pipe	825	825mm-C100 Concrete Sewer (3-5 m deep)	m	2.0	$1,361	$2,722
N/A	Bypass Pumping	Hillside Park (Lexington Rd)	Bypass Pumping	N/A	Bypass Pumping of Sewage (1 week)	per week	11.8	$4,700	$55,253
Alt 6B: Subtotal									**$353,520**
Alt 6C: Upgrade Sewer									
3906	Pipe	Hillside Park (Lexington Rd)	Sanitary Upgrade	1050	1050mm-C100 Concrete Sewer (3-5 m deep)	m	107.4	$1,825	$196,027
3907	Pipe	Hillside Park (Lexington Rd)	Sanitary Upgrade	1050	1050mm-C100 Concrete Sewer (3-5 m deep)	m	107.7	$1,825	$196,574
N/A	Bypass Pumping	Hillside Park (Lexington Rd)	Bypass Pumping	N/A	Bypass Pumping of Sewage (1 week)	per week	11.8	$4,700	$55,253
Alt 6C: Subtotal									**$447,854**

Opinion of Probable Cost Details

I&I Reduction Plan							Planning Periods		
Equipment	Description	Unit	Unit Quantity	Unit Cost ($/unit)	Capital Cost (Yr 1)	Capital Cost (>Yr 1)	2014 to 2019	2019 to 2024	2024 to 2029
Flow Monitor Operation	Includes installation, removal and maintenance costs	ea	8	$4,000	$32,000	$32,000	$160,000	$160,000	$160,000
Flow Monitor Purchase Cost	Includes data logger, sensor, cables and installation	ea	8	$4,200	$33,600		$33,600		
Flow Monitor Maintenance	Maintenance visits for Purchased Monitors (15% of cost)	ls	8	$600	$4,800	$4,800	$24,000	$24,000	$24,000
I&I Reduction Plan Subtotal					**$65,600**	**$32,000**	**$193,600**	**$160,000**	**$160,000**